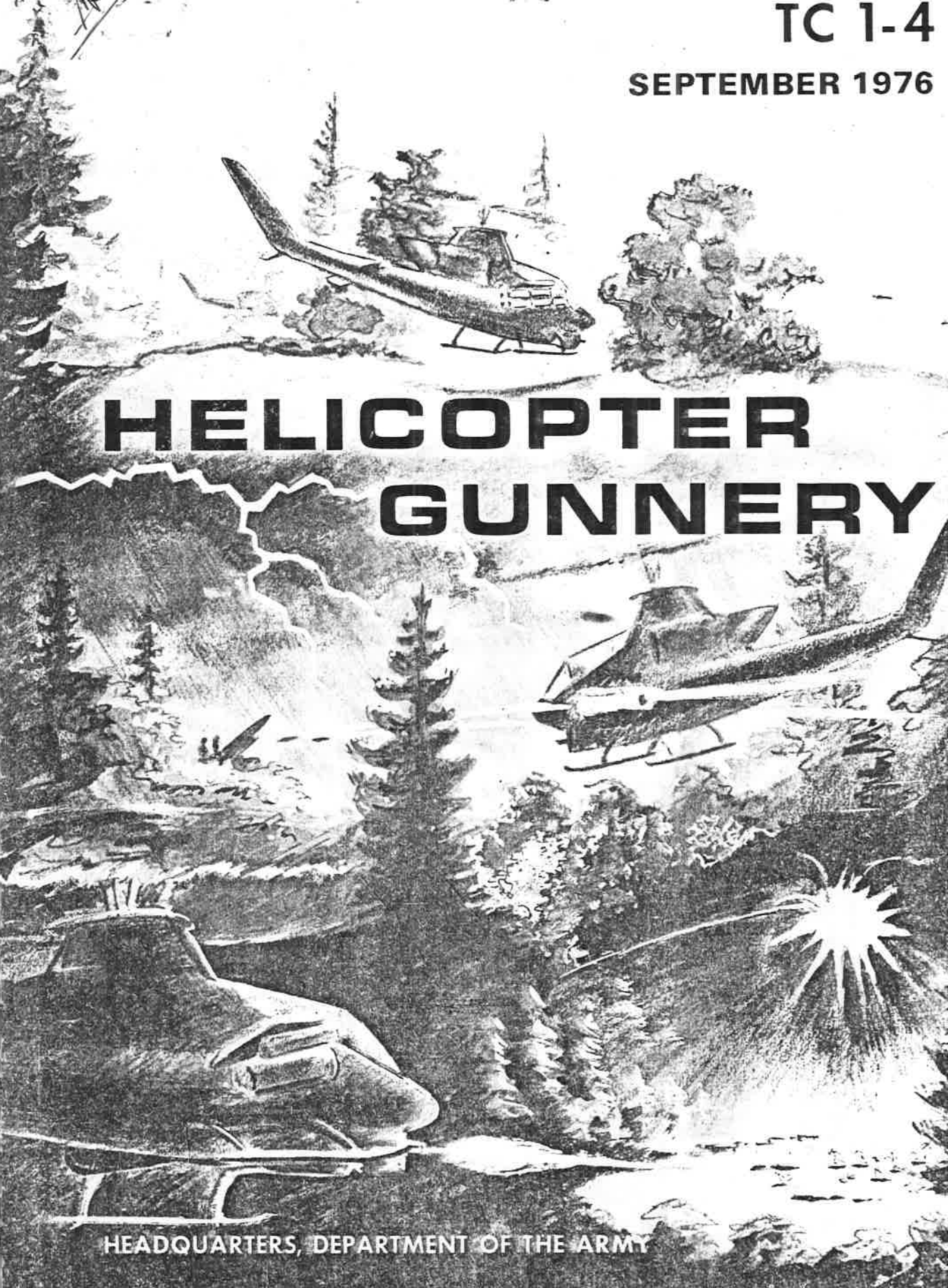
TC 1-4

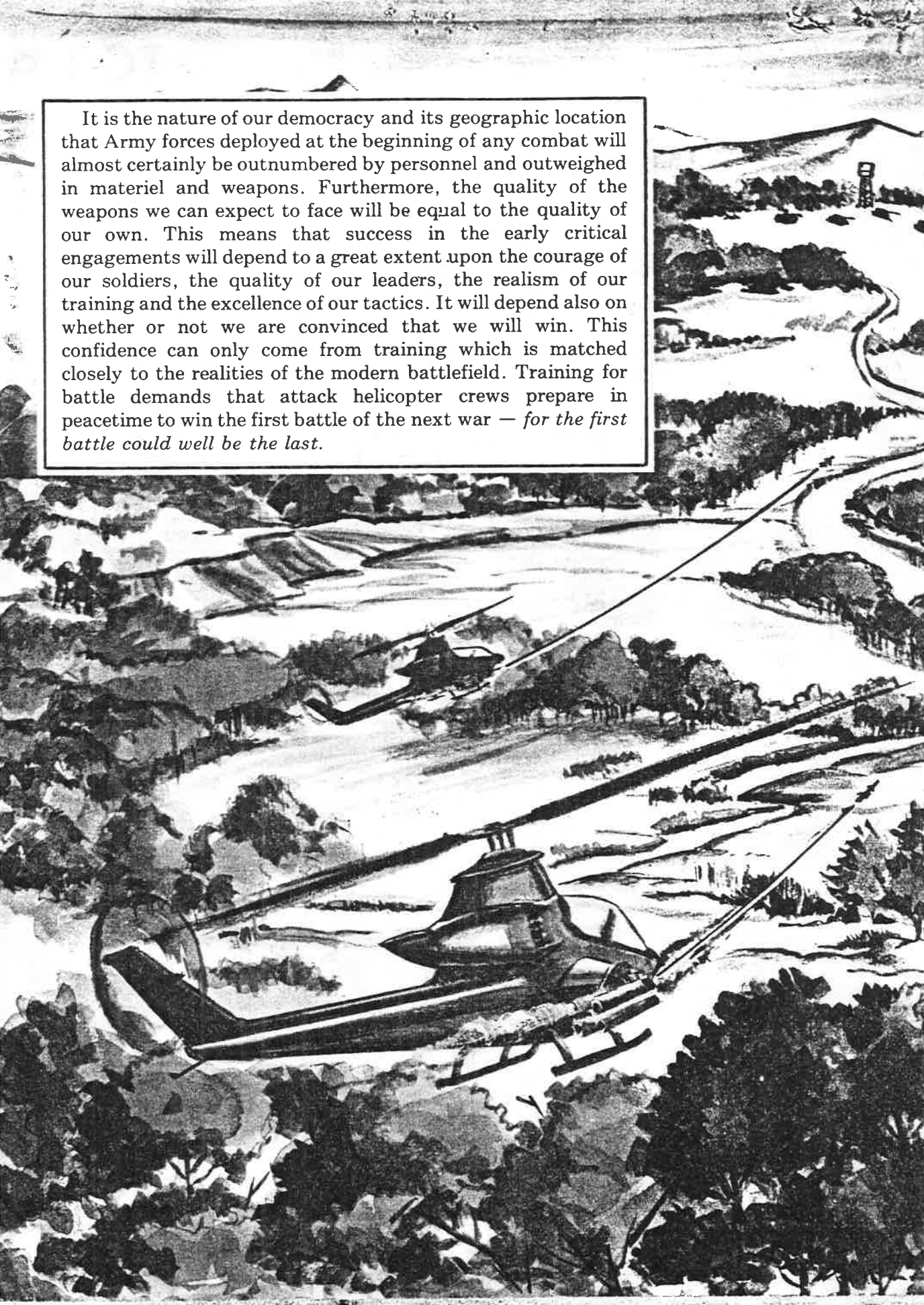
SEPTEMBER 1976



HELICOPTER GUNNERY

HEADQUARTERS, DEPARTMENT OF THE ARMY

It is the nature of our democracy and its geographic location that Army forces deployed at the beginning of any combat will almost certainly be outnumbered by personnel and outweighed in materiel and weapons. Furthermore, the quality of the weapons we can expect to face will be equal to the quality of our own. This means that success in the early critical engagements will depend to a great extent upon the courage of our soldiers, the quality of our leaders, the realism of our training and the excellence of our tactics. It will depend also on whether or not we are convinced that we will win. This confidence can only come from training which is matched closely to the realities of the modern battlefield. Training for battle demands that attack helicopter crews prepare in peacetime to win the first battle of the next war — *for the first battle could well be the last.*



Statement: The word "he" is intended to include both the masculine and the feminine genders. Any exceptions to this will be so noted.

PREFACE

PURPOSE AND SCOPE

This training circular explains the basic principles for tactical helicopter gunnery. It provides information for aircrews in the understanding and skill development of available armament subsystems with emphasis on the TOW missile system as an effective tank killer. Emphasis is placed on the development of new delivery techniques that must be used by the aircrews to place effective fire on the target at terrain flight altitude. TC 1-4 addresses the ballistic factors which affect the accuracy of a projectile and the sighting techniques used to hit the target. Future employment concepts are discussed based on new types of ammunition and improved weapons subsystems. Also presented are the procedures used to request fires from attack helicopters. Specific requirements for a helicopter gunnery training program are discussed with TC 17-17, Gunnery Training for Attack Helicopters, being identified as the primary reference for establishing a training program. Information is provided which identifies the requirements for door gunner training. This publication is not designed to contain technical information about each weapon subsys-

tem nor to present a detailed aerial gunnery training program. It is, however, designed to be used in conjunction with the applicable publications referenced in the text.

THREAT AWARENESS

To employ the attack helicopter effectively, aircrews must have a thorough knowledge of the capabilities and limitations of the enemy's air defense weapons systems. With this knowledge and up-to-date information of the enemy situation, aircrews can more effectively employ the attack helicopter. Additionally, the aircrews must recognize the enemy's electronic capability. This capability may degrade the effectiveness of the attack helicopter by reducing command and control communication while increasing the effectiveness of the enemy's target acquisition capabilities. The success of the aircrew on the battlefield will be directly proportional to the manner in which it learns to cope with the enemy threat. Each aircrew must use every available means to eliminate or restrict the capability of the enemy air defense and electronic warfare systems. FM 90-1 and TC 17-17 contain information on threat weapons that may be encountered in future battlefields.

BEFORE YOU CONTINUE—

IF YOU ARE NOT THOROUGHLY

FAMILIAR WITH THE THREAT

READ FM 90-1 AND TC 17-17

TRAINING LITERATURE

FM 90-1, Employment of Army Aviation Units in a High Threat Environment, is the capstone for Army aviation employment doctrine. It develops 13 principles of employment that are applicable to the combat environment. Because TC 1-4 has a specialized target audience, the discussion of these principles will be limited to their interaction with the armed helicopter employment. Although the ability of the attack helicopter aircrews to fire the weapons systems accurately is of utmost importance, they must also be proficient in the basic aviator skills. To aid aircrews in improving their ability to perform in a high threat environment, new publications have been developed and are available for their use. Of primary importance to the Army aviator are FM 1-1, Terrain Flying; FM 1-5, Instrument Flying and Navigation for Army Aviators; FM 1-60, Army Air Traffic Management in the Combat Zone; TC 1-28, Rotary Wing Night Flight; and TC 17-17, Gunnery Training for Attack Helicopters. An understanding of the information contained within these publications will improve the survivability of the aircrew and contribute to winning the first battle.

The proponent for this training circular is the US Army Aviation Center. Users are encouraged to submit recommended changes or comments to improve the publication. Please explain fully any recommendation to help evaluate the change. Key your specific comments to the appropriate page. If possible, use the attached comment card or DA Form 2028 (Recommended Changes to Publications and Blank Forms). Forward comments to the *Commander, US Army Aviation Center, ATTN: ATZQ-TD-TL-GP (TEL: AUTOVON 558-3801/2482), Fort Rucker, Alabama 36362.*

*TRAINING CIRCULAR
No. 1-4

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 30 September 1976

HELICOPTER GUNNERY

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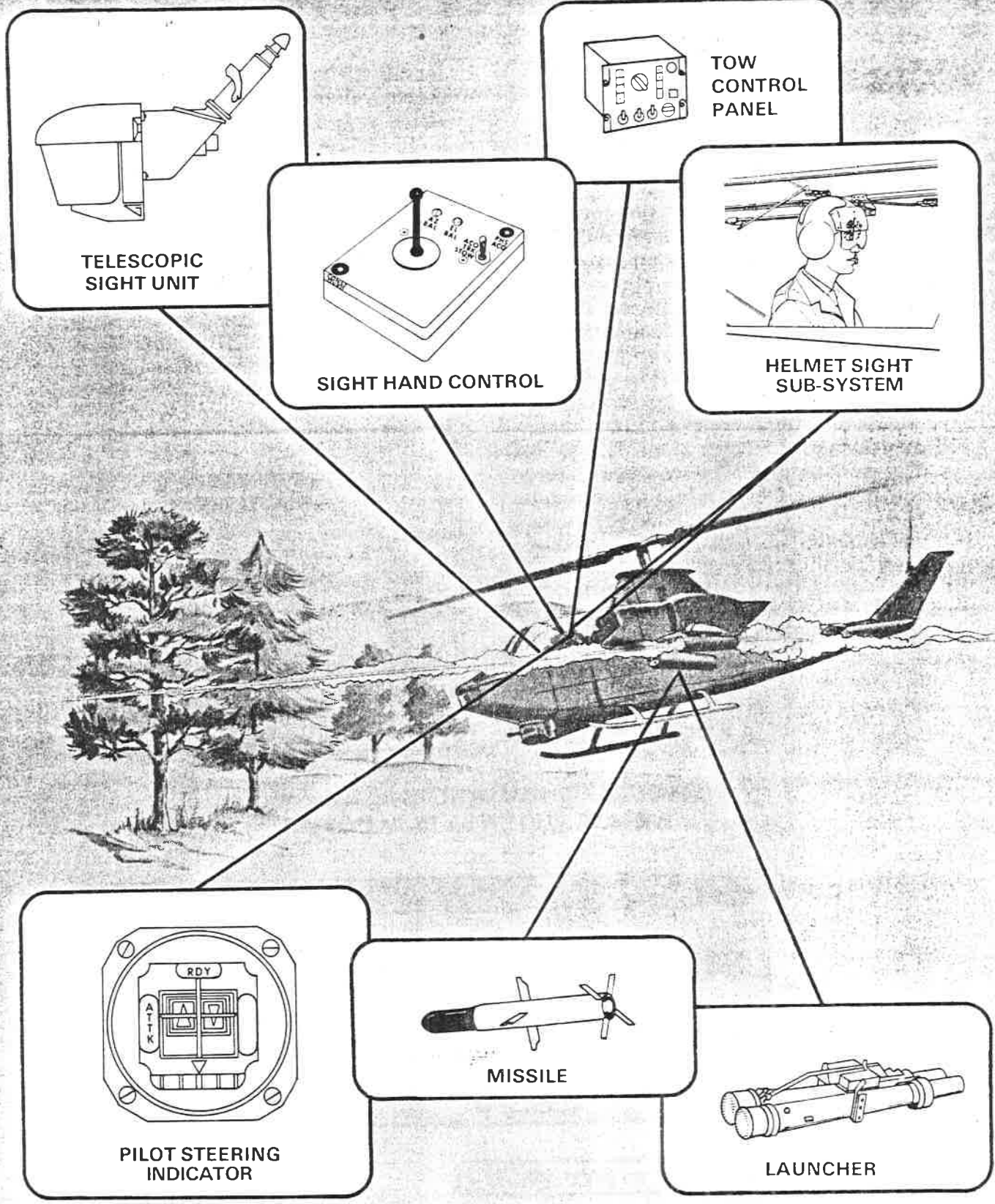
CHAPTER ONE

M65 AIRBORNE TOW

INTRODUCTION

The doctrine of aggressor nations is to conduct massive assaults using armor and mechanized infantry units. To defeat such a superior force, it must be engaged with a weapons system that is highly accurate, lethal, and can be effectively employed in a high threat environment. The attack helicopter employing the M65 airborne TOW missile provides the ground commander an antiarmor weapon that is completely mobile and when properly integrated with the combined arms team, can move about the battlefield to bring heavy firepower to bear on tanks and other armored vehicles. This chapter discusses the capabilities and limitations and firing techniques for the TOW missile that an attack helicopter crew must know in order to effectively employ the system. Information pertaining to the M22 guided missile is contained in TM 55-1520-220-10 and will not be addressed in this publication.



M65 AIRBORNE TOW SYSTEM

CAPABILITIES AND LIMITATIONS

➡The attack helicopter is capable of carrying eight TOW missiles. When armed with fewer missiles, a mix of different armament subsystems can be carried. The effective range of the TOW missile is from 500 to 3,750 meters when fired from hover flight. Range may be increased by firing with forward airspeed. This engagement distance varies according to airspeed prior to and after the missile is launched. Although certain conditions (e.g., high density altitude, blowing dust and snow caused by rotorwash) may prevent the helicopter from firing the missile at a hover, the primary delivery technique is hover fire. When firing from a hover, additional range is not a factor. The time of flight of the missile is determined by the distance to the target. When firing from the hover, the maximum time of flight for the missile is 21.5 seconds. The time of flight when engaging targets at ranges less than maximum range is depicted in table 1-1. The capability of the TOW missile to accurately destroy targets at the maximum range gives the aircrew a standoff advantage over most air defense weapons.

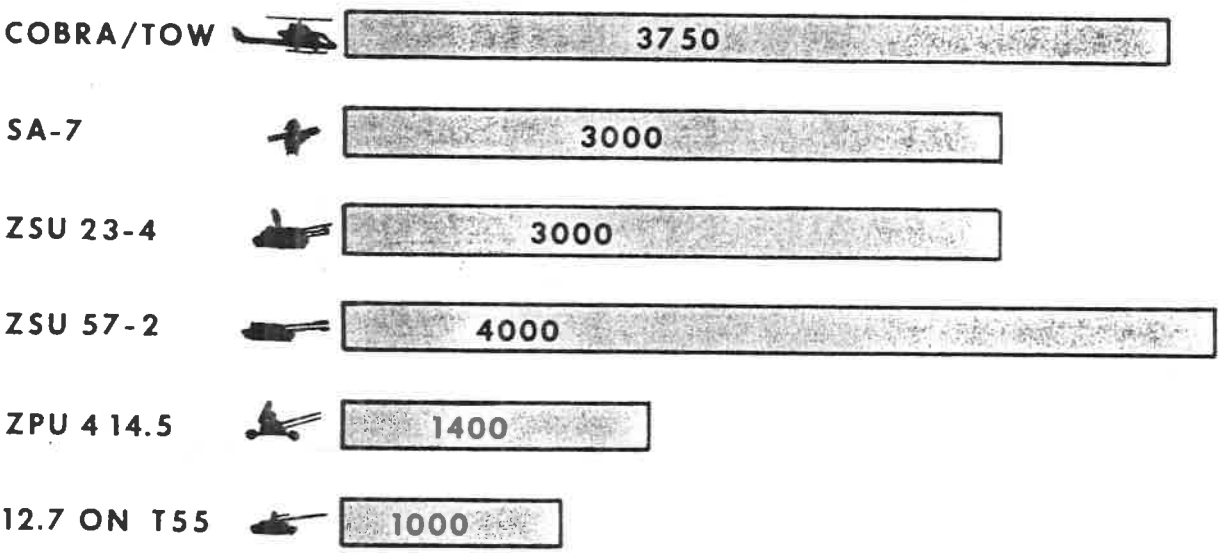
Note. The extended range (3,750 meters) TOW missile system will not be available to units in the field until August 1976. After this date, both models of the TOW missile will be issued until the supply of 3,000-meter TOWs is exhausted. Aircrews must be aware of which missile is being fired to insure the target being engaged is within the effective range of the missile.

TOW MISSILE TIME OF FLIGHT

Meters	Seconds
3,750	21.5
3,000	15.0
2,000	8.8
1,000	4.0
500	2.0

Table 1-1

RANGE OF THE AIRBORNE TOW VS AIR DEFENSE WEAPONS



➡When the missile flies beyond the limit of the wire, impacts with the target, or experiences loss of IR line of sight, automatic wirecut occurs at the launcher. If for any reason during an engagement it becomes necessary to terminate the engagement, the gunner can cut the wire by depressing the WIRECUT switch on the TOW control panel. The pilot can cut the wire by placing the weapon control switch located on the pilot's armament control panel to the pilot "PLT" position. There is no mechanical device to cut the wire while in flight. If the electrical wirecut fails, the pilot should land as soon as possible and crewmember must remove the wire. If the helicopter is flown with the wire suspended from the launcher, the wire may become entangled in the control systems. To minimize this unsafe condition, the helicopter should be flown in a slip. A safe airspeed will be determined by the effect of the wire as it streamlines behind the helicopter. The direction of the slip should be toward the side of the helicopter where the wire is suspended. This technique places the tail rotor the greatest distance from the wire as it trails from the launcher.

➡When firing the turret weapons using the fast rate of fire during missile engagement, vibration of the TSU will be experienced. If the turret must be fired, a slow rate of fire will minimize this vibration; however, the probability of weapon jamming is increased at slower rates of fire. When the trigger to fire the missile is pulled, the turret weapons will not fire for a period of 3 seconds. After this, the turret will function normally.

➡When the missile is fired, a danger area is created behind the helicopter. This area forms a 90° arc extending 45° each side of the launcher, out to a distance of 50 meters. Additionally, a caution area extending 25 meters beyond the danger zone should be avoided. Launch signature within this area is easily recognizable from the flank; however, when observed from the front, it is difficult to detect during the day. The launch signature is more pronounced when firing in-ground effect over the terrain which has sparse vegetation. When firing at night, the glow produced by the missile motor is easily recognizable from all directions.

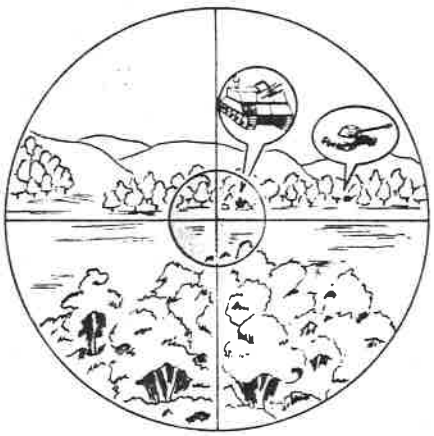
➡The light intensity of the target is reduced approximately 70 percent when the gunner views the target through the telescopic sight unit (TSU). Normally, daylight conditions are adequate to see a target at the maximum range of the TOW missile system. Poor visibility and cloud coverage will reduce the range that the target can be seen; however, if the target can be seen with the unaided eye, it can be seen through the TSU. To acquire target during darkness, flares must be used to illuminate the area. Also by viewing targets through the TSU with night vision goggles (AN/PVS-5's), targets can be acquired and engaged. The range at which the target can be acquired using the AN/PVS-5's will depend upon the ambient light level. When firing the TOW missile at night, the gunner's ability to track the target is impaired by the light intensity of the missile motor. This condition affects the use of the AN/PVS-5 more than the unaided eye. Normally, the missile must be beyond 1,000 meters before the effect of the missile motor is degraded enough so that the gunner can track the target through the TSU using the AN/PVS-5.

➡When engaging targets at ranges beyond 3,000 meters,the missile must fly with a nose-high attitude to maintain altitude. This angle progressively increases as the velocity of the missile decreases. The effectiveness of the warhead is degraded due to the angle of impact with the target.

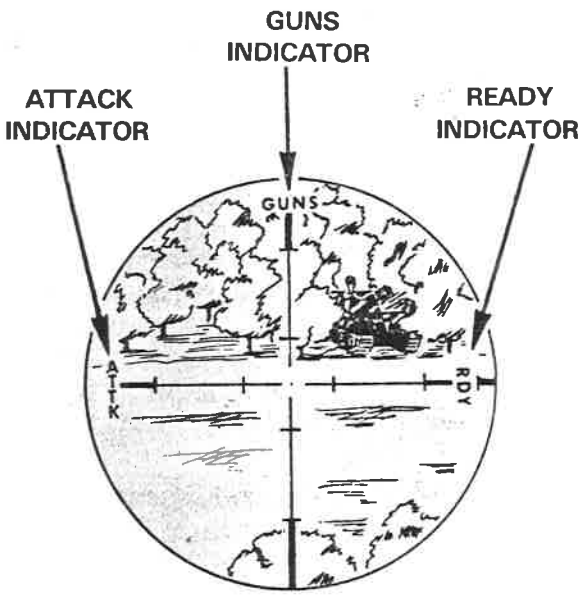
➡The accuracy of the TOW missile is affected by the boresight of the upper launcher module and telescopic sight

unit (TSU). The boresight of the helmet sight subsystem affects the target acquisition capability and the accuracy of the turret weapons. When either of these components is replaced, a boresight must be performed. Additionally, the boresight of the system is checked during each periodic inspection of the helicopter. Special equipment and training are required to perform a boresight. Normally, boresighting will be performed by direct support contact teams. For specific information, refer to appropriate TM 9-series on TOW missiles.

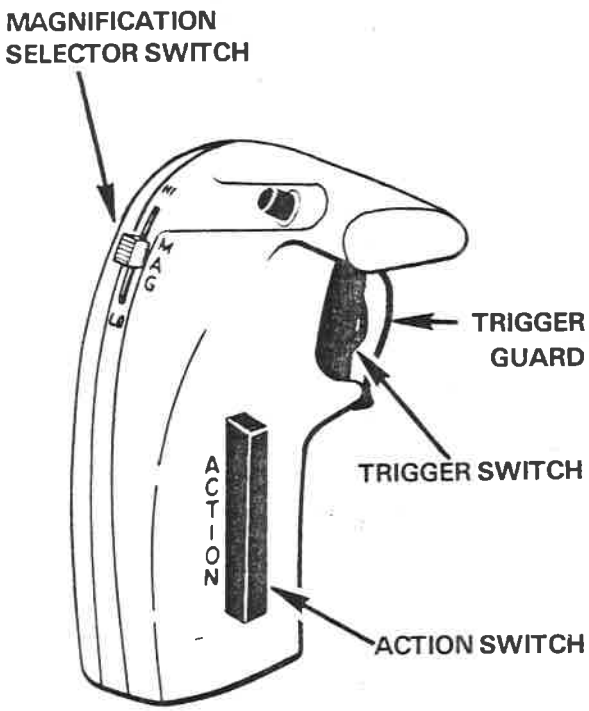
➡ The TOW missile system provides the gunner with a stabilized telescopic sight with low (2 power) and high (13 power) magnification. The gunner can select either power by moving the magnification ("MAG") switch on the left handgrip of the telescopic sight unit (TSU). When the LO MAG position is selected, a 28° field of view can be seen by the gunner. Movement of the telescope turret (bucket) is accomplished by applying pressure to the sight hand control. The bucket containing the optics can be moved in azimuth 110° left and right of the helicopter centerline, 30° elevation, and 60° depression. The sight will slew at a rate of 100° per second both in elevation and azimuth in the LO MAG mode. In the HI MAG mode, it slews at a rate of 3° per second in azimuth and elevation. When operating in the LO MAG mode, a circle is displayed on the sight reticle. This circle represents the field of view for high power magnification. It is used by the gunner to determine when he can transition to high power without losing contact with the target or in which direction and how far he must search to acquire the target after switching to HI



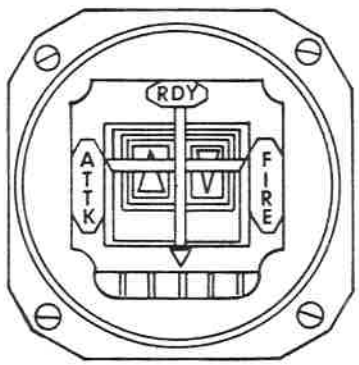
FIELD OF VIEW
LOW MAGNIFICATION



FIELD OF VIEW
HIGH MAGNIFICATION

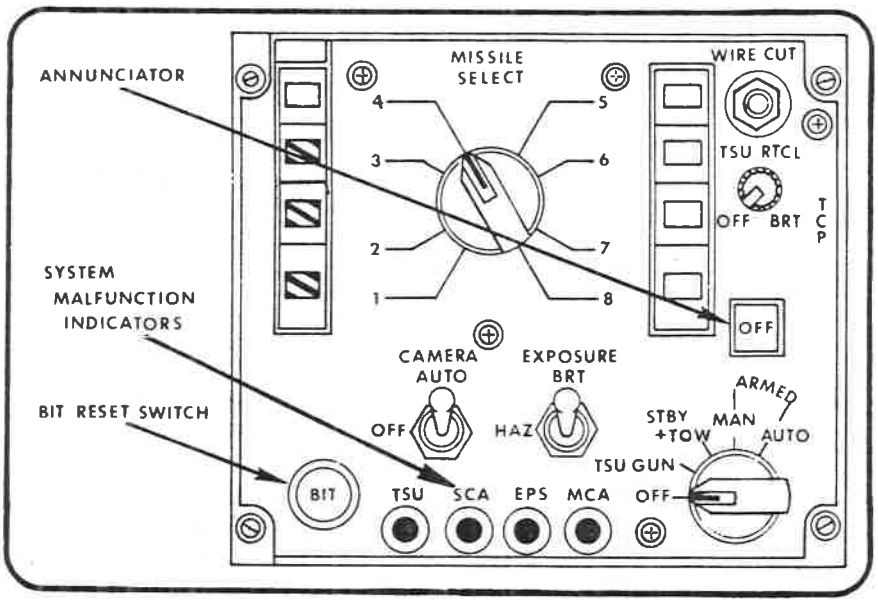


TSU LEFT HAND GRIP



PILOT'S STEERING
INDICATOR

MAG. When operating in the high power position, a 4.6° field of view can be seen by the gunner. The azimuth and elevation limits of the optics are the same as for the low power mode of operation. The reticle image displayed on the gunsight consists of an outer circle with a vertical and horizontal crosshair. Positioned along the horizontal crosshair is a series of vertical marks. These marks are provided to aid the gunner in estimating range to the target. The distance between the outer vertical marks is 10 mils with 2 mils separating the inner marks. At a distance of 3,400 meters, the T-62 tank will fit lengthwise within the 2-mil opening. At the center of the sight reticle is an opening which is 0.4 mils wide. This area will displace a 54-inch square at the maximum range (3,750 m) of the missile and is the aiming point for the gunner when sighting on targets. Also presented on the sight reticle are three status indicators (ATTK, RDY, and GUNS). The ATTK indicator illuminates when the HI MAG position is selected and the action bar on the gunner left handgrip is depressed. At the same time the ATTK indicator illuminates on the TSU, a similar ATTK flag is presented on the pilot's steering indicator (PSI), and steering information is provided for the pilot to maneuver the helicopter within prelaunch constraints. Depressing the action bar also energizes the motion compensator circuitry which aids the gunner in tracking. The RDY flag illuminates both on the TSU and the PSI when the helicopter is within prelaunch constraints. The GUNS indicator illuminates when the TSU/GUN position is selected on the TOW control panel and the action bar is depressed. When operating in this mode, the gunner can use the TSU to aim the turret weapons.



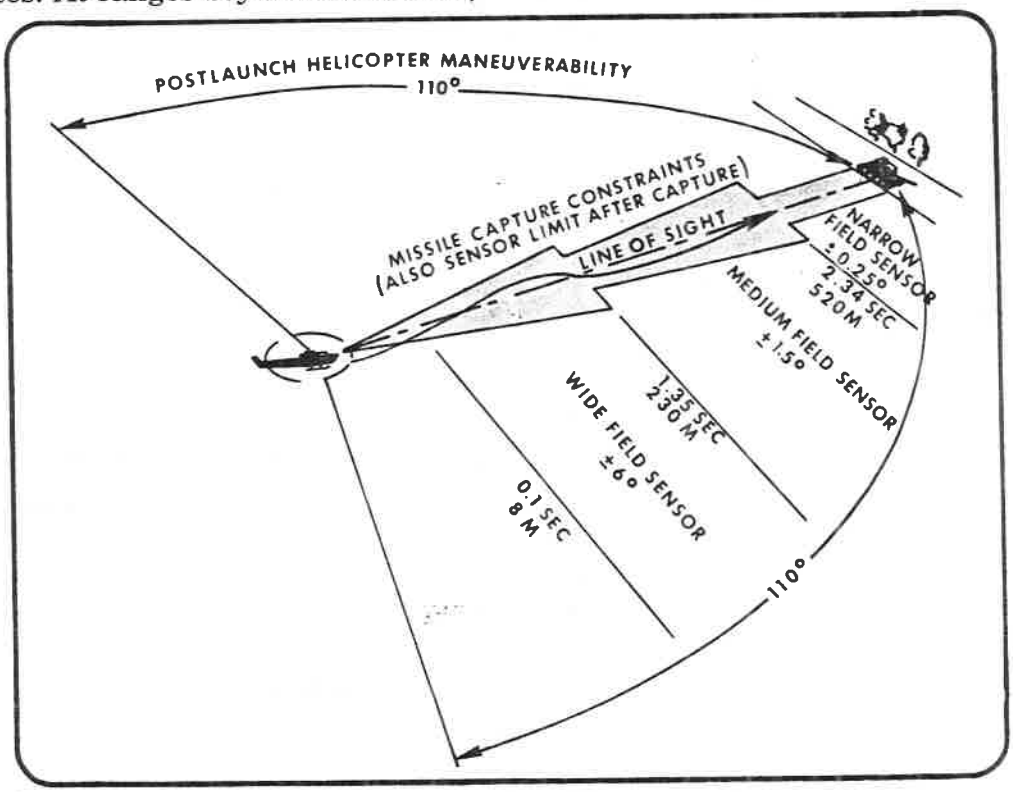
TOW CONTROL PANEL

➡ Incorporated into the TOW missile system is a built-in test (BIT) feature. The electronic circuit of this test feature is activated automatically when power is applied to the TOW missile system or by depressing the BIT reset switch on the TOW control panel. During the runup of the helicopter, the pilot should place the arm switch on the pilot's armament control panel to either the "STBY" or "ARMED" position and the gunner must position the mode selector switch on the TOW control panel to "STBY TOW" to operate BIT. Once the circuit has been tested, a "PWR ON" (power on) flag will illuminate on the annunciator of the TOW control panel. Positioning the mode switch on the TOW control panel to the "ARMED" position locks out the BIT circuitry and the system will go directly to arm. This procedure should be used only as an emergency procedure. The time required to complete the BIT will vary from 30 to 120 seconds. The test circuit is incorporated into the missile guidance, stabilization, tracking, and power supply components. Continuous monitoring of the circuit occurs only in the power supply. It does not test the missile which has been selected for firing. Test circuits have not been incorporated into other components because of their high reliability, safety requirements, and the capability of the operator to observe a malfunction.

Upon recognizing a malfunction of any component that is tested by BIT prior to firing, the gunner should initiate another test. Due to the variables of the test circuit, the gunner should recycle as many as eight times to confirm that a malfunction exists before aborting the mission. In a critical situation, an attempt should be made to determine if the malfunction is within the test circuit by firing the missile. If the missile can be captured and tracked to the target, the TOW missile system is operational and continued firings can be conducted even though a malfunction is indicated. A failure may occur in a component after it has been tested by BIT and the gunner would not be aware of the failure prior to

firing a missile. If a missile is lost during launch, the gunner should depress the BIT switch to determine if a failure has occurred. Firing should be discontinued if a component failure is indicated. The TOW missile system incorporates a line replacement unit (LRU) maintenance concept. This capability allows organizational maintenance personnel to replace components (black boxes) determined to be defective by the built-in test feature. Other maintenance on the system must be performed by a direct support contact team using the TOW/Airborne System Test Set (TASTS) and TOW System Evaluation Missile (TSEM).

➨ The distance the missile can be laterally tracked by the field sensor from the optical line of sight decreases as the range of the missile from the helicopter increases. At ranges beyond 520 meters, the capture capability of the field sensor is limited to 0.25° left or right of the optical line of sight. If at any time the missile flies outside these limits for .5 of a second or the field sensor loses infrared (IR) line of sight with the missile for .5 of a second, automatic wirecut will occur. Thus, rapid heading changes which exceed the tracking rate of the telescopic sight unit (TSU) will cause the field sensor to lose track with the missile and automatic wirecut will occur. To minimize this limitation, the gunner must limit the rate of turn to less than the slew rate of the TSU, which is equal to 3° per second or a standard rate turn. When tracing a moving target or engaging a target while the helicopter is moving, terrain obstacles may appear between the helicopter and the missile that masks the IR emitter from the field sensor and cause automatic wirecut.



TOW LAUNCH AND CAPTURE CONSTRAINTS

➡The helicopter must remain unmasked while the missile is in flight to the target. Although the time of flight of the missile is short, the additional time required by the aircrew to acquire the target and maneuver the helicopter within prelaunch constraints gives the enemy sufficient time to acquire and engage the helicopter. If within effective range of an enemy weapon system, the helicopter is vulnerable to enemy fire. Selection of a good firing position where the helicopter blends into the background is important to minimize visual detection by the enemy.

➡The effect of gravity drop of the missile after it leaves the launcher is automatically compensated for by the system setting a quadrant elevation of +1° above optical line of sight on the launcher. Additionally, the control surfaces (fins) impart an upward flight of the missile during launch. These design features enable the pilot to fire the missile with only minimum obstacle clearance, thus reducing the exposure of the helicopter. Normally, if the pilot can maintain optical line of sight with the target, it can be engaged; however, this is not always true. In order to engage a target, the helicopter must be within the prelaunch constraints. Terrain variation and meteorological conditions may require the pilot to maneuver the helicopter beyond the prelaunch constraints. To engage a target, the heading of the helicopter must be within 2.5° left and right, 6° in elevation and depression, and 5° in roll of target line of sight. When these prelaunch constraints are exceeded, the missile will not fire using normal procedures. The gunner can override the system by depressing the constraint override switch on the sight hand control; however, the probability of capturing the missile after launch is unlikely. Firing while in a strong crosswind is the most difficult condition that confronts a pilot. A maneuver which allows the pilot to maintain alignment over a stationary position is to slip the helicopter into the wind. An out-of-trim condition is not critical; however, the roll constraint limitations cannot be exceeded. If movement of the helicopter is not critical, roll can be minimized by allowing the helicopter to drift downwind, while heading alignment is maintained with the antitorque pedals. After the missile has been launched, the helicopter is free to

PRELAUNCH MANEUVERABILITY CONSTRAINTS

Heading	+2.5°
Elevation/Depression	6°
Roll	5°

Table 1-2

POSTLAUNCH MANEUVERABILITY CONSTRAINTS

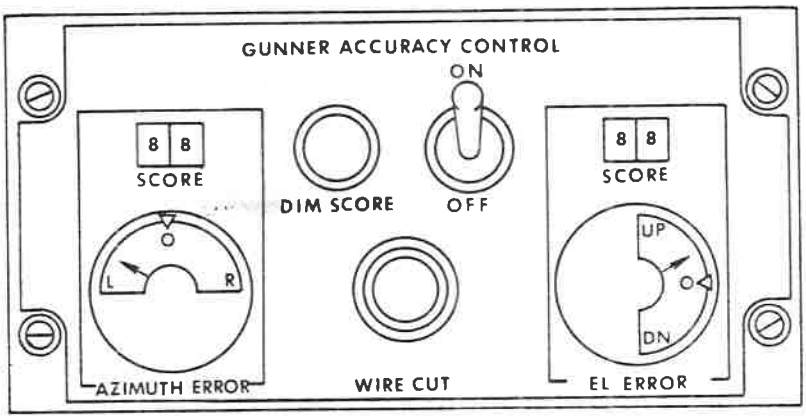
Heading	+110°
Elevation/Depression	30°/60°
Roll	30°

Table 1-3

maneuver within the postlaunch constraints as long as optical line of sight is maintained with the target. The postlaunch constraints are azimuth 110° left or right, 30° elevation, 60° depression, and 30° roll of the target line of sight. Although the helicopter can be maneuvered either direction after a missile has been fired, to prevent the missile wire from becoming entangled in the turret weapons and breaking, the helicopter should be maneuvered in the opposite direction from the side it was fired.

If the wire breaks while in flight, the command signal that is being received at the time will continue to be applied to the missile steering system until impact. For example, if the last signal is to climb, the missile will continue to climb until the velocity decreases and gravity causes it to descend. Wirecut can be initiated by either the gunner or the pilot at any time the missile is in flight.

Incorporated into the TOW missile system is a training aid which enables the aircrew to conduct simulated missions without firing a missile. To use the system, the missile status panel in the pilot's compartment must be removed and the gunner's accuracy control panel (GACP) is installed. Additionally, an IR signal emitter must be placed on the target. The procedures for acquiring a target and the launch sequence are the same. When the gunner activates the trigger, a visual display is presented on the GACP depicting tracking error in azimuth and elevation and a scoring sequence begins. The pilot can advise the gunner which direction to correct if a tracking error exists. The scoring sequence lasts 12 seconds. At the end of this time, a readout in percentage of time the gunner maintained track on the target is presented both in azimuth and elevation/depression. The gunner's proficiency is determined by the score he achieved. The tracking sequence will continue for a total of 23 seconds; however, the gunner will not be graded after 12 seconds of the exercise. The tracking sequence may be terminated at any time by depressing the wirecut switch. When the wirecut switch is used, the engagement procedure must be initiated to activate the GACP circuit.



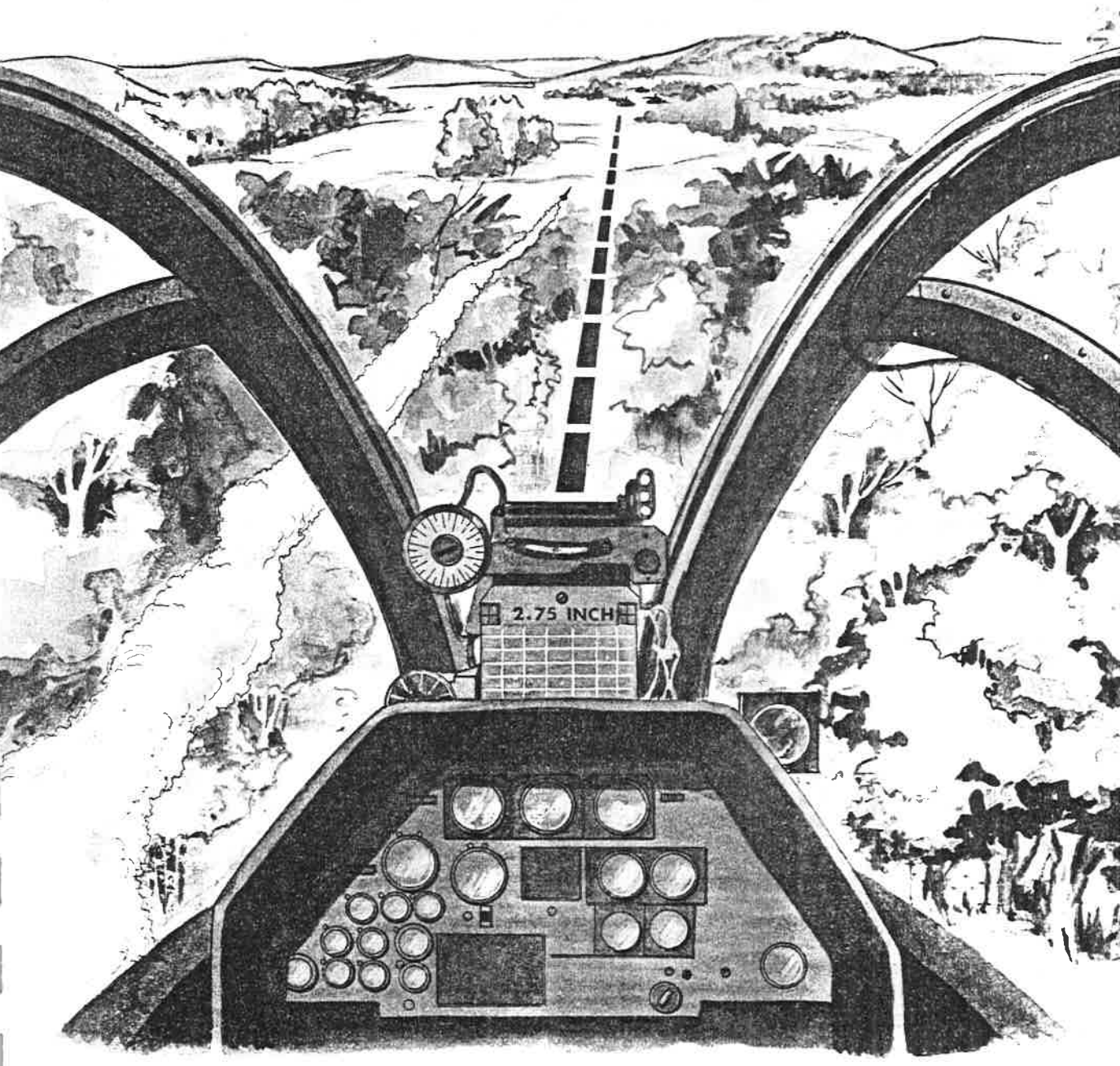
GUNNERY ACCURACY CONTROL PANEL

CREW DUTIES
TOW MISSILE SYSTEM

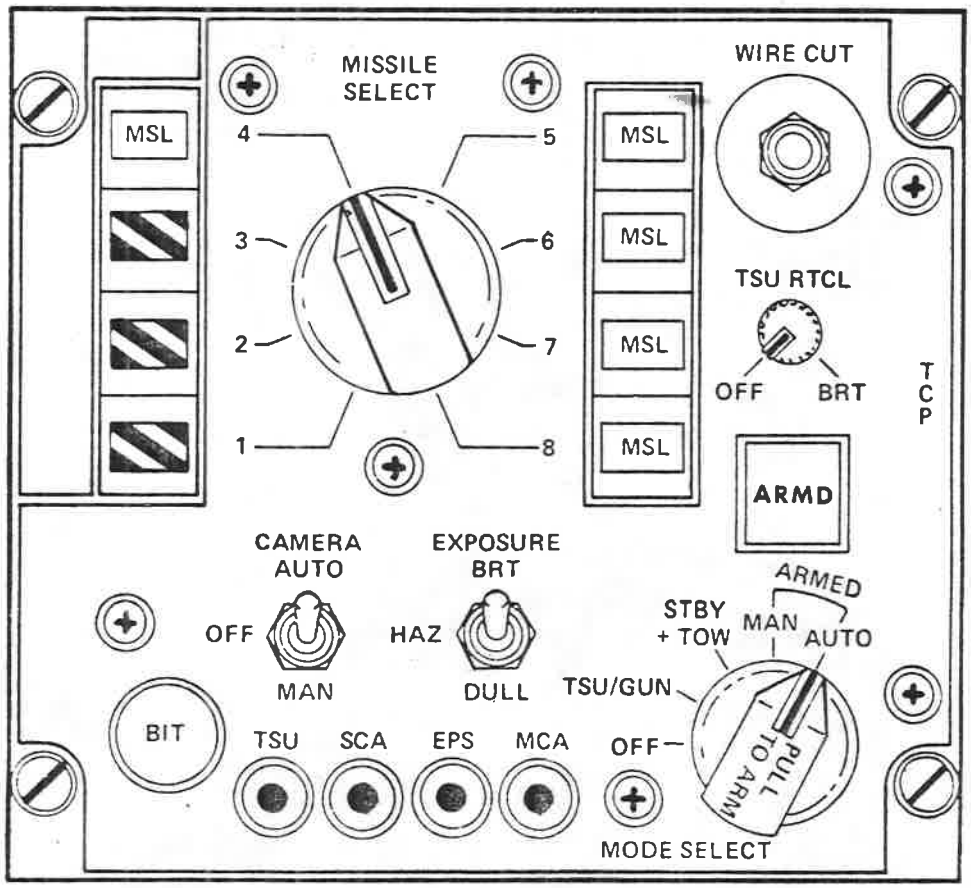
Scout	Gunner	Pilot
	Holding Areas	
Locate target	Coordination and planning	Coordination and planning
	Perform weapons checks	Perform aircraft checks
Target handoff	Receive target handoff	Maneuver to attack position
	Attack Positions	
Command and control	Arm weapons systems	Position helicopter in firing position
	Acquire target	Acquire target
Acquire additional targets	Track target Fire missile	Maneuver helicopter to within prelaunch constraints
Recovery of downed aircraft	Track target	Maneuver helicopter within postlaunch constraints Acquire additional targets

TARGET ACQUISITION

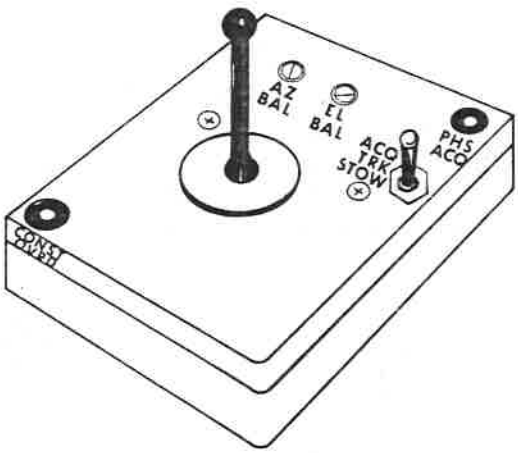
Upon receiving a target handoff, the pilot maneuvers the helicopter into the firing position aligning it in the approximate direction to the target. Before unmasking, the gunner must place the mode selector switch on the TOW control panel to either the MAN or AUTO armed position. The AUTO mode automatically selects the next missile to be fired and is the preferred mode of operation. Normally, both the gunner and the pilot will use their helmet sight to acquire the target. If the target is identified by the gunner, he will place the selector switch on the sight



hand control in the acquire ("ACQ") position while maintaining alignment of the helmet sight on the target. Upon activation of the ACQ switch, the telescopic sight unit (TSU) slews to the target and the gunner's helmet sight retracts. The gunner must insure that the TSU has slewed to the target before releasing pressure on the ACQ switch. If the pilot identifies the target using the helmet sight system ("PHS"), the gunner must place the selector switch on the sight hand control in the "TRK" position and depress the PHS ACQ button. Automatically, the TSU will slew to the target and the gunner's helmet sight retracts. Targets that are at the maximum range may be difficult to acquire using the helmet sight

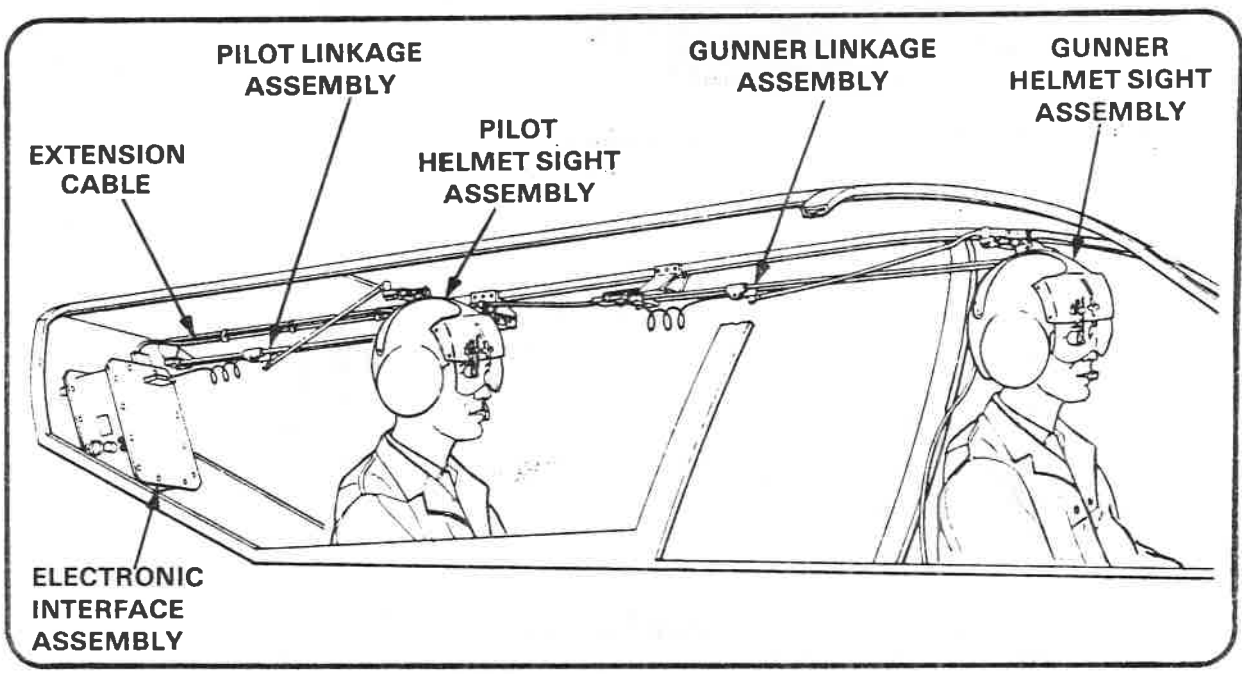


TOW CONTROL PANEL



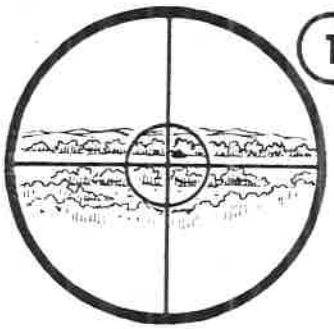
SIGHT HAND CONTROL

because these sights do not provide any magnification. To aid the gunner in acquiring targets that are difficult to see with the unaided eye, the low power capability of the TSU should be used to search for targets. When using the TSU to acquire targets, the mode select switch on the sight hand control should be placed in the TRK position. At any time the gunner is searching for the target and the pilot acquires a target using his helmet sight, the gunner can depress the PHS ACQ button on the sight hand control and the TSU will slew to the azimuth the pilot observes the target. If the gunner is using the helmet sight when the target is acquired, he must transition to the TSU after the helmet sight retracts. To acquire the target in the TSU, LOW MAG position is used. After the target is acquired in the TSU, the gunner is free to track the target using the sight hand control.



HELMET SIGHT SUBSYSTEM

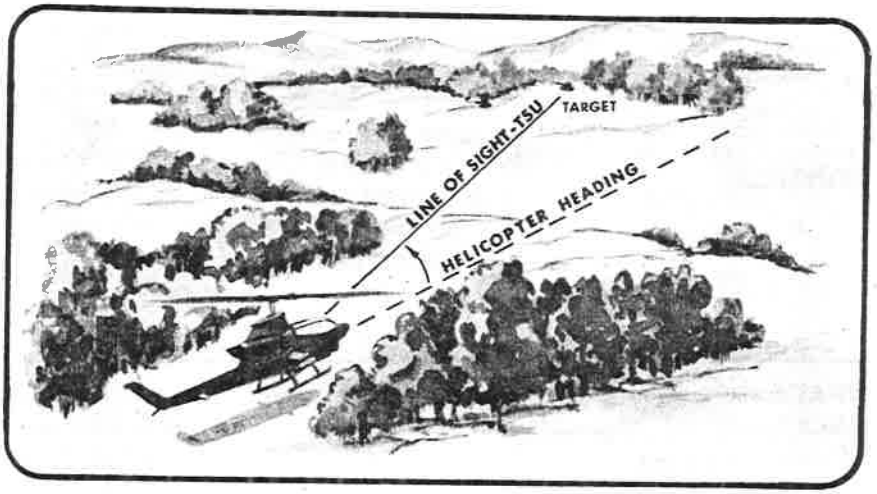
TO INITIATE THE ENGAGEMENT SEQUENCE:



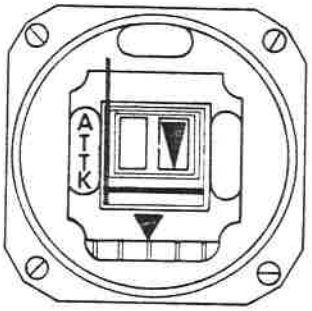
1 THE GUNNER POSITIONS THE TARGET WITHIN THE HIGH MAGNIFICATION LIMITS OF THE TSU

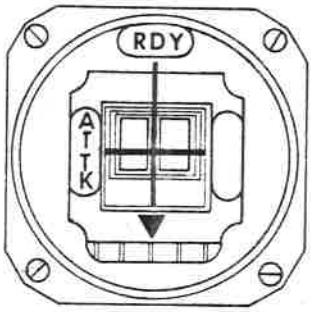
2 THEN SWITCHES TO HIGH MAGNIFICATION AND DEPRESSES THE ACTION BAR ON THE LEFT HANDGRIP

TARGET ACQUISITION

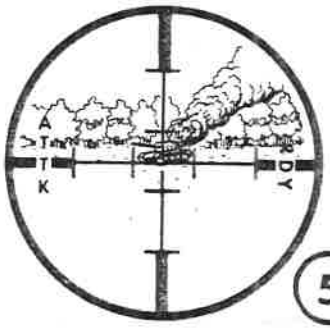


3 THE ATTACK FLAG ILLUMINATES ON THE PSI





4 THE PILOT MANEUVERS THE HELICOPTER TO CENTER THE SIGHT LINES ON THE PSI



5 THE GUNNER FIRES WHEN THE READY FLAG ON THE TSU ILLUMINATES

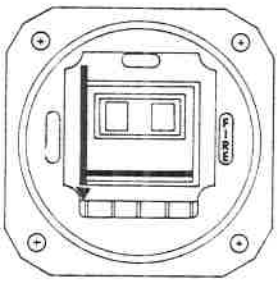
ENGAGEMENT SEQUENCE

After acquiring the target, the gunner applies corrections with the sight hand control to bring the target within the inner circle of the sight reticle. As the target comes within the inner circle, the gunner selects the HI MAG position and depresses the action bar on the left handgrip. Immediately, the ATTK (attack) flag on the gunner sight reticle and the pilot's steering indicator illuminate. The gunner continues to track the target, keeping the aiming point on the center of mass while the pilot maneuvers the helicopter within prelaunch constraints. Both azimuth and pitch attitude constraints for prelaunch are displayed to the pilot within the pilot's steering indicator (PSI). A vertical and horizontal sight line position bar displayed within the PSI provides steering information. These bars react very similar to the course deviation needle and glide slope of an ILS receiver. If the vertical bar is deflected to the left of center, the helicopter heading is right of the optical line of sight and must be corrected to the left. Likewise, if the horizontal bar is below center, the attitude of the helicopter is above the optical line of sight and the attitude must be adjusted downward. Steering information (attitude) is also provided the pilot by the ascend/descend pointers located within the inner box of the PSI. If at any time the pointer appears, an attitude adjustment is required in the direction indicated by the pointer to position the helicopter parallel to the optical line of sight. Although it is desirable to center the sight line position bars, prelaunch constraints are satisfied when both bars are within the inner box. Once the helicopter is within the prelaunch constraints, the RDY flag on the pilot's steering indicator and the RDY flag on the sight reticle of the TSU illuminate. At this time, all prelaunch requirements have been satisfied and the missile is ready to be fired. If the helicopter is maneuvered outside the prelaunch constraints after receiving a "ready" (RDY) indication, it will extinguish and the helicopter must be maneuvered within the prelaunch constraints to fire the missile. Roll constraints are not displayed on the PSI; however, the RDY flag will not illuminate if the helicopter is banded more than 5°. To fire the missile, the action bar and the firing trigger on the TSU left handgrip must be depressed.

TRACKING

The probability of the missile's hitting the target is primarily dependent upon the gunner's ability to track a target. Failure to apply immediate and smooth corrections by the gunner is the primary cause of tracking error. As the range to the target increases, the effect of tracking error on the trajectory of the missile increases and the probability of hit decreases. Even with a perfect track, the missile will have small deviations (normally less than 2 feet) about the line of sight; therefore, it is essential that tracking error be reduced. To reduce tracking error and increase the hit probability, the aircrew should (1) track the center of mass of a target; (2) track smoothly and avoid jerky corrections (after getting off a target, smoothness and quickness are critical to get back on the center of mass); (3) maintain a constant heading during engagements (when heading changes must be made, turns should be at a slow rate, flat bank angle, not exceeding 6° per second rate of turn or a standard rate turn); and (4) maintain a constant airspeed when engaging targets using running fire techniques. If airspeed changes must be made, the attitudes of the helicopter should be adjusted very slowly.

In addition to the tracking error, other variables exist which will affect the gunner's ability to track. For example, smoke or terrain features may momentarily block the gunner's line of sight to the target. Also, the enemy will initiate evasive maneuvers which cause the gunner to lose line of sight with the target. When the loss of a target occurs during engagement, the following procedures should be followed by the gunner: (1) Continue tracking at the same rate as before the target was lost; (2) do not attempt to move the line of sight around in an attempt to see the target; (3) when the target becomes visible again, make smooth but immediate corrections to position the sight reticle on the center of mass, avoiding step-inputs; and (4) if the target does not appear before the missile reaches the range to the target, the gunner should project an intercept point and track to this point until impact or the missile is beyond the range of the target.



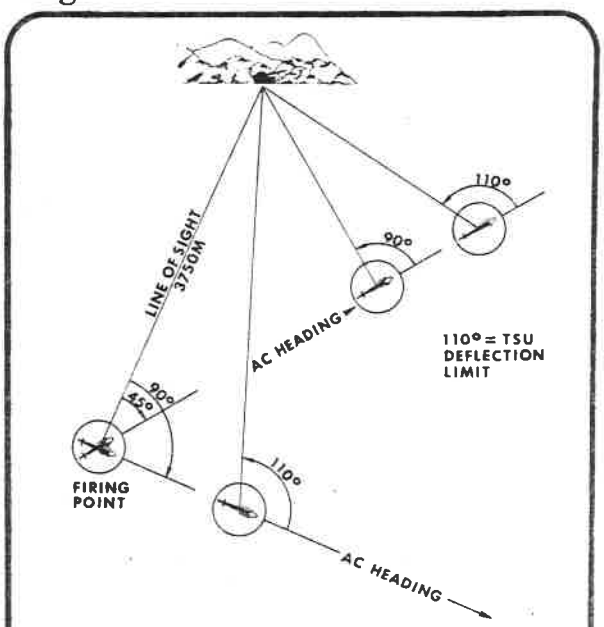
PILOT'S STEERING INDICATOR

POSTLAUNCH

After the missile has been fired, a "FIRE" indication appears on the pilot's steering indicator. At this time, the missile has been fired and the pilot can maneuver within postlaunch constraints as long as optical line of sight to the target can be maintained. The pilot receives visual indication of the helicopter's attitude in relation to optical line of sight to the target by observing the position of the elevation/depression sight line position bar and the ascend/descend pointers. The postlaunch constraints are depicted on the outer box.

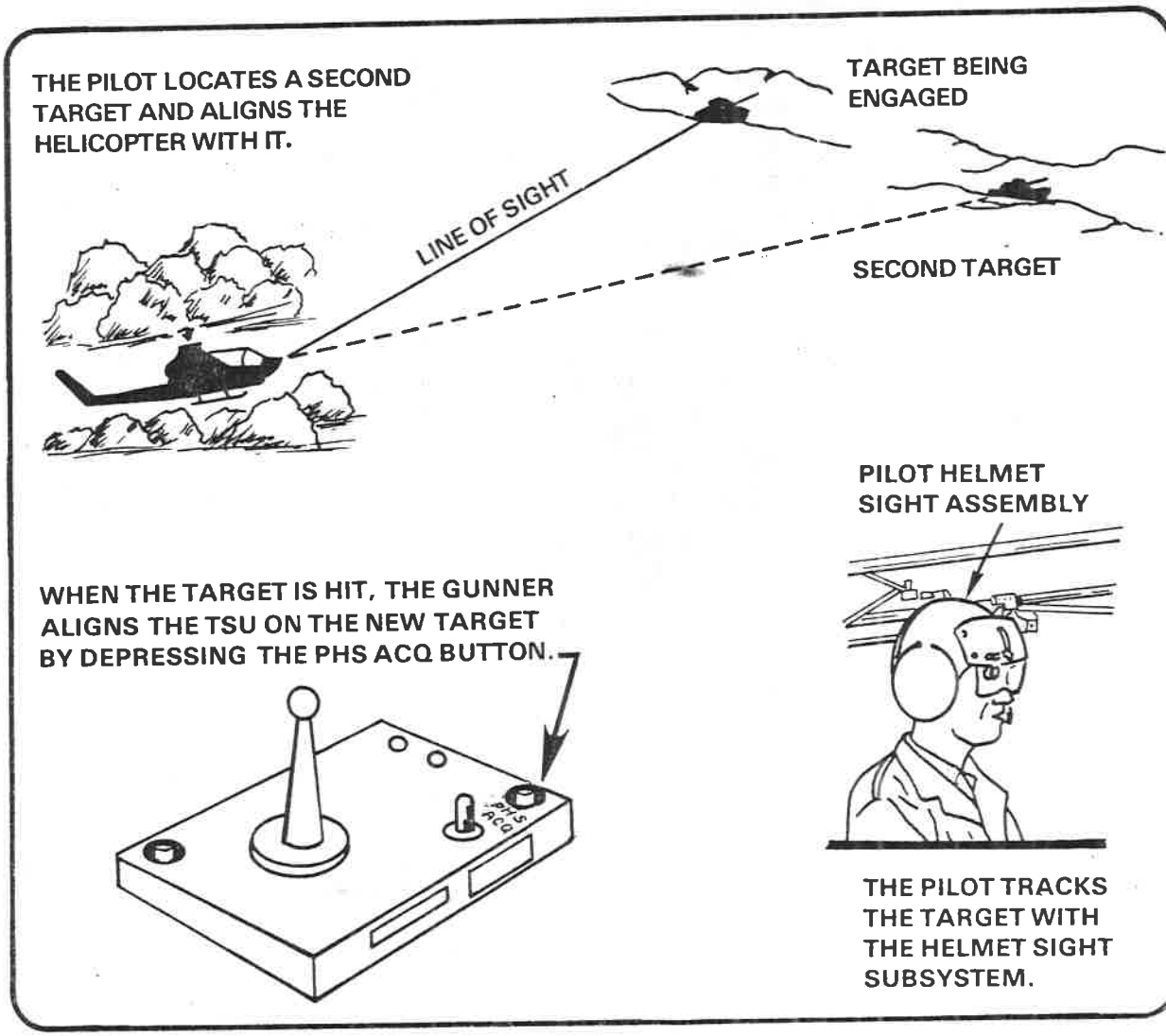
The angular difference between the TSU line of sight and the heading of the helicopter is also indicated by the course scale azimuth pointer located below the outer box of the PSI. The horizontal scale contains azimuth angle markers spaced 55° apart. The position of the azimuth pointer left or right of center indicates the number of degrees the helicopter is displaced from the TSU and the direction the pilot must correct to center the azimuth pointer. The azimuth sight line position bar and the azimuth pointer will remain aligned as they displace laterally.

At anytime the helicopter exceeds the postlaunch constraints, optical line of sight with the target cannot be maintained and the missile will miss the target.

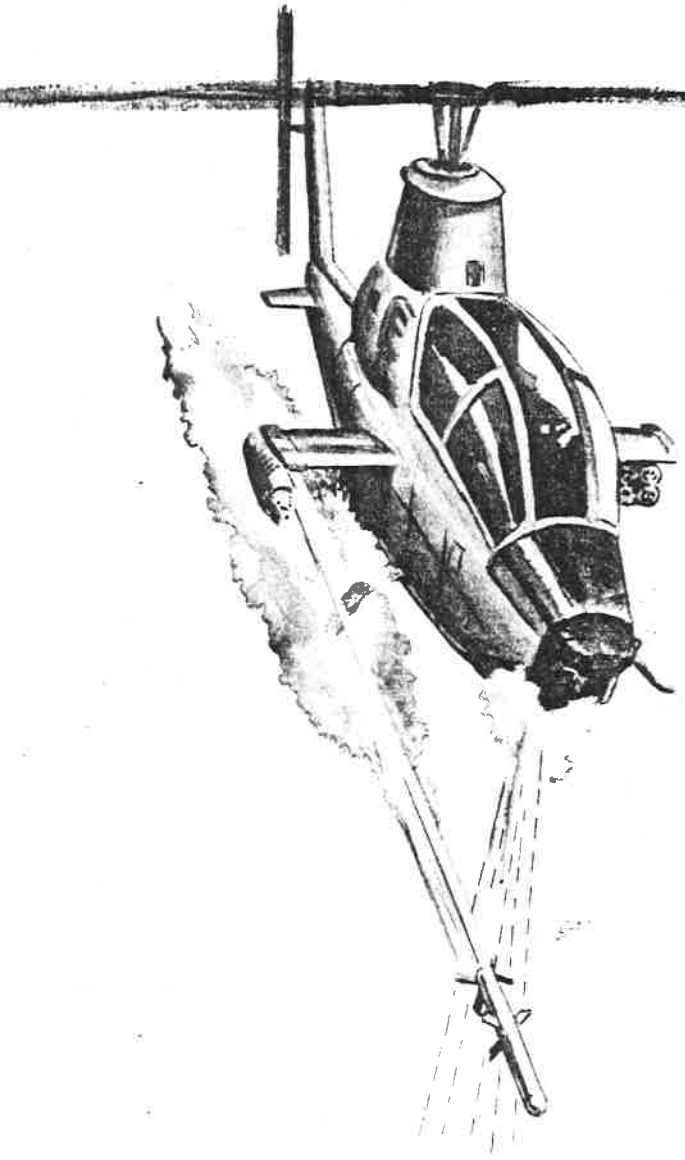


AS THE DISPLACEMENT OF THE ANGLE BETWEEN THE LINE OF SIGHT AND HEADING INCREASES, THE LIMITS OF LATERAL MANEUVER DURING MISSILE FLIGHT DECREASE.

After the missile has hit the target or exceeded its range limitation, the fire indicator on the pilot's steering indicator will extinguish, indicating automatic wirecut has occurred. Prior to the wirecut, the pilot should evaluate the tactical situation to determine if another engagement can be conducted from the same firing position. This decision is based upon the enemy situation and the availability of targets that can be engaged from the firing position. If the pilot determines another engagement can be conducted, he should select the closest target to the one being engaged and maneuver the helicopter, without exceeding the post-launch constraints, to align it with the target. Also, he must sight on the target with his helmet sight. When wirecut occurs, the gunner depresses the PHS ACQ button and the TSU slews to the target. The remaining sequence for firing the missile is the same as previously discussed. Target acquisition by the pilot during engagement reduces the time required for multiple engagements, thus minimizing the exposure of the helicopter and improving survivability.


THE PILOT LOCATES A SECOND TARGET AND ALIGNS THE HELICOPTER WITH IT.
TARGET BEING ENGAGED
LINE OF SIGHT
SECOND TARGET
PILOT HELMET SIGHT ASSEMBLY
WHEN THE TARGET IS HIT, THE GUNNER ALIGNS THE TSU ON THE NEW TARGET BY DEPRESSING THE PHS ACQ BUTTON.
PHS ACQ
THE PILOT TRACKS THE TARGET WITH THE HELMET SIGHT SUBSYSTEM.

Each time a missile is fired, it leaves a wire on the battlefield. It may fall to the ground or remain suspended by terrain features. Because of the hazards of wire to helicopters operating at terrain flight altitudes, precaution must be taken by aircrews when passing through areas where known heavy concentrations of missile firing have occurred. During postmission briefings, aircrews of attack helicopters that have fired missiles should report where these firings occurred, and these positions should be plotted on a wire hazard map. In a tactical environment, the flight operation of an aviation unit assigned attack helicopters armed with the TOW missiles should maintain the wire hazard map. Coordination with the S3 at a higher level of command is required to insure complete coverage of the battlefield.

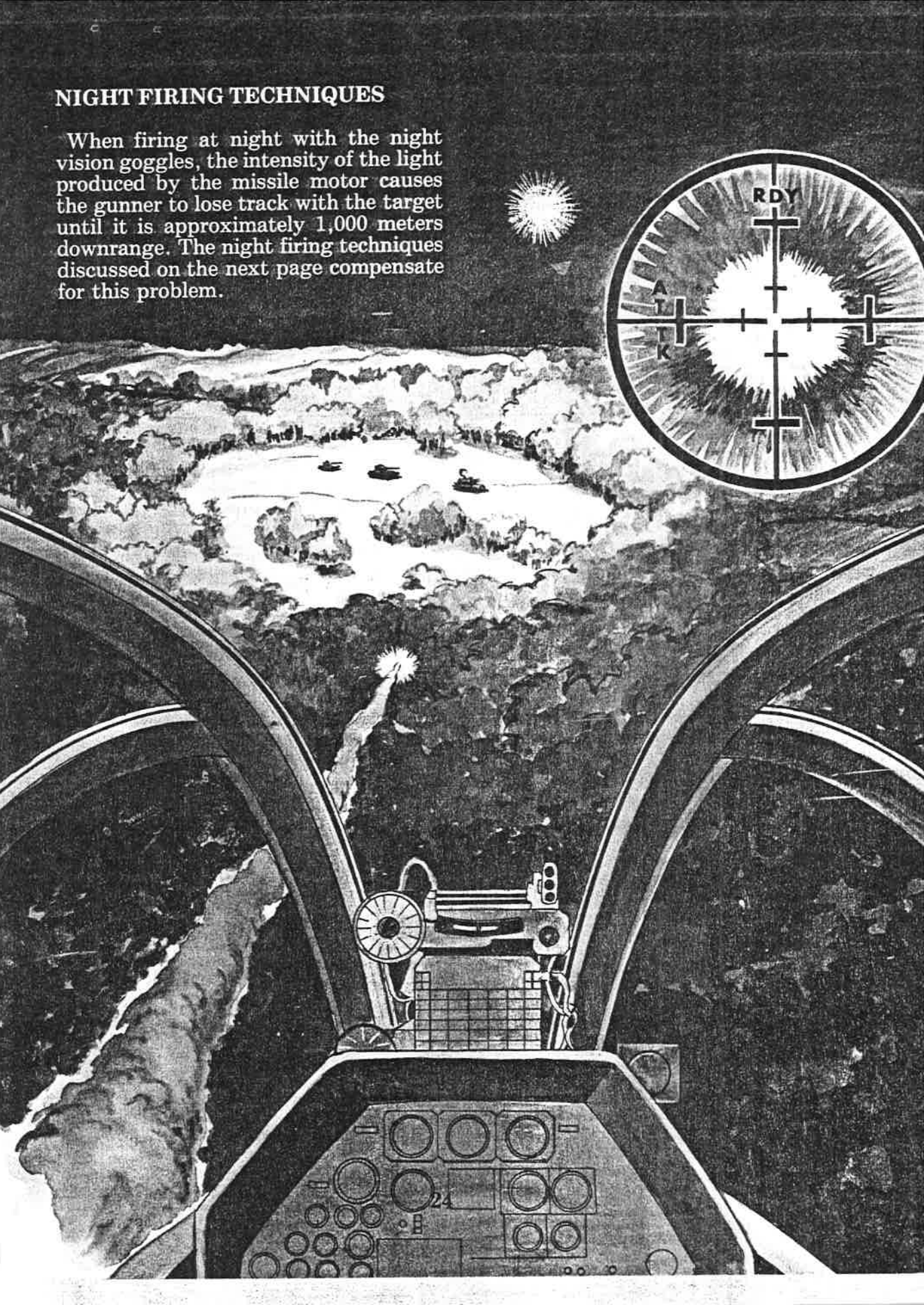


TURRET FIRING

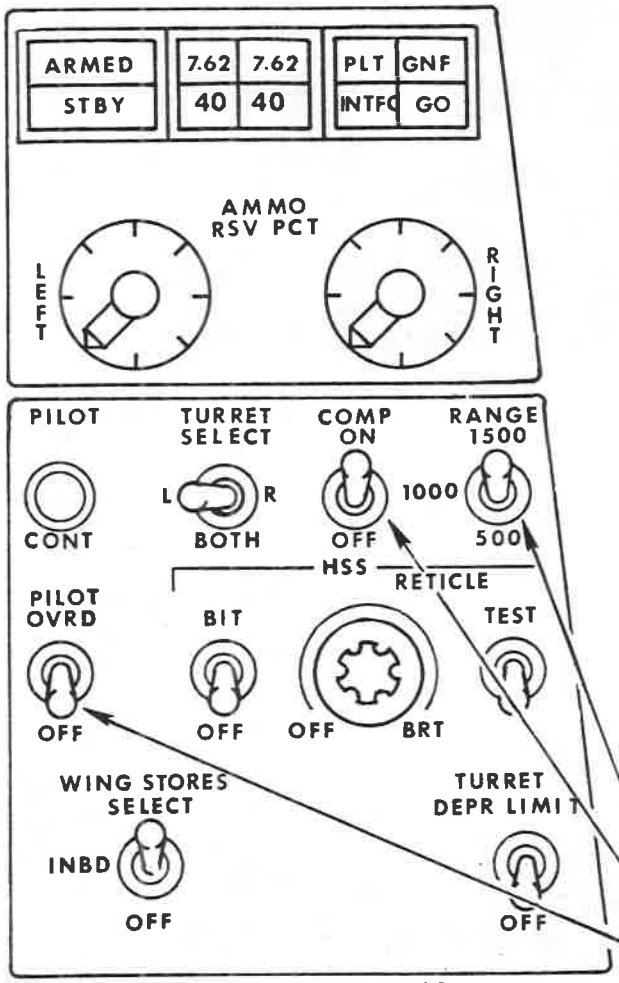
The turret weapons can be fired by the pilot when the gunner is firing or preparing to fire a missile if the mode select switch on the TOW control panel is positioned to STBY TOW or ARMED, MAN/AUTO. In anticipation that the pilot may fire a turret weapon during these conditions, the gunner's armament control panel should be set for turret firing. This requires that the range estimation switch be set on the engagement range which most targets will occur and the compensation switch be placed in the COMP ON position. In order that the gunner maintain control of the TOW missile system, the weapon control switch on the pilot's armament control panel must be in the GUNNER position. He must also select the weapon that will be fired by positioning the weapon select switch in either LEFT-BOTH-RIGHT position. When a target is to be engaged, the pilot sights on it with the helmet sight. Upon depressing the action bar on the cyclic, the gun turret will slew in azimuth to the point seen by the helmet sight and the gun barrel will elevate to achieve the range selected. The pilot fires the turret by depressing the turret trigger switch on the cyclic. By depressing the

NIGHT FIRING TECHNIQUES

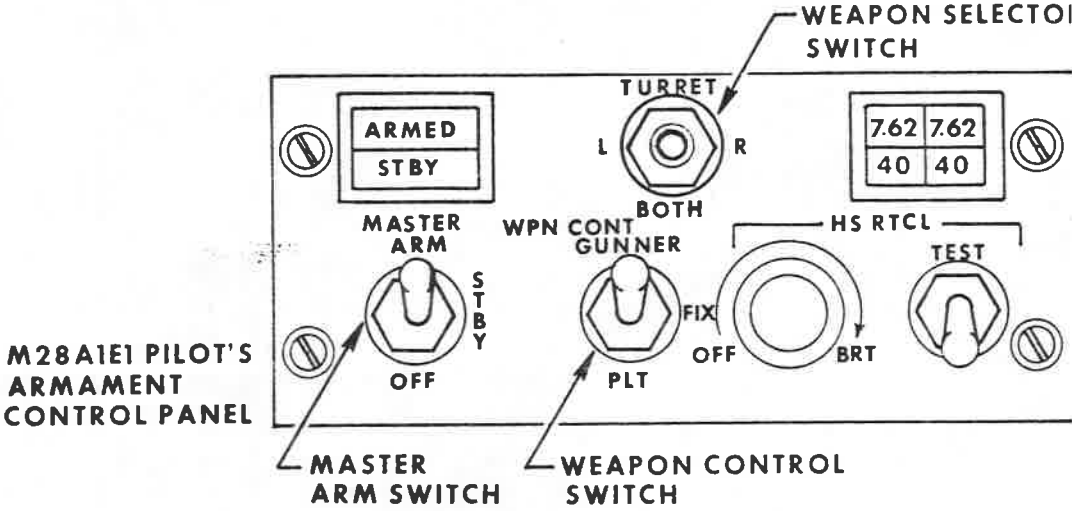
When firing at night with the night vision goggles, the intensity of the light produced by the missile motor causes the gunner to lose track with the target until it is approximately 1,000 meters downrange. The night firing techniques discussed on the next page compensate for this problem.



switch to the first indent position, a low rate (2,000 rounds per minute) of fire is selected. Full depression of the trigger switch fires the machinegun at the fast (4,000 rounds per minute) rate of fire. To adjust the impact point of the projectile onto the target, the pilot repositions the helmet sight both in azimuth and elevation while depressing the action bar until the desired effect is achieved. If at any time the pilot selects the PLT position on the pilot's armament control panel to fire the turret weapon, the gunner cannot fire the missile or the turret weapons. To gain control, the gunner must activate the pilot override switch on the gunner's armament control panel. Activation of the pilot override switch will not power the TOW missile system. Additional modes of firing turret and stowed weapons are discussed in appropriate technical publications for the M6 airborne TOW missile system.



M28A1E1 GUNNER'S ARMAMENT CONTROL PANEL



M28A1E1 PILOT'S ARMAMENT CONTROL PANEL

Foldout

SUMMARY

The TOW missile system provides the force commander an effective antiarmor capability; however, the effectiveness of the system is dependent upon the ability of the aircrew to fire the weapon accurately and the tactics used to engage armor targets.

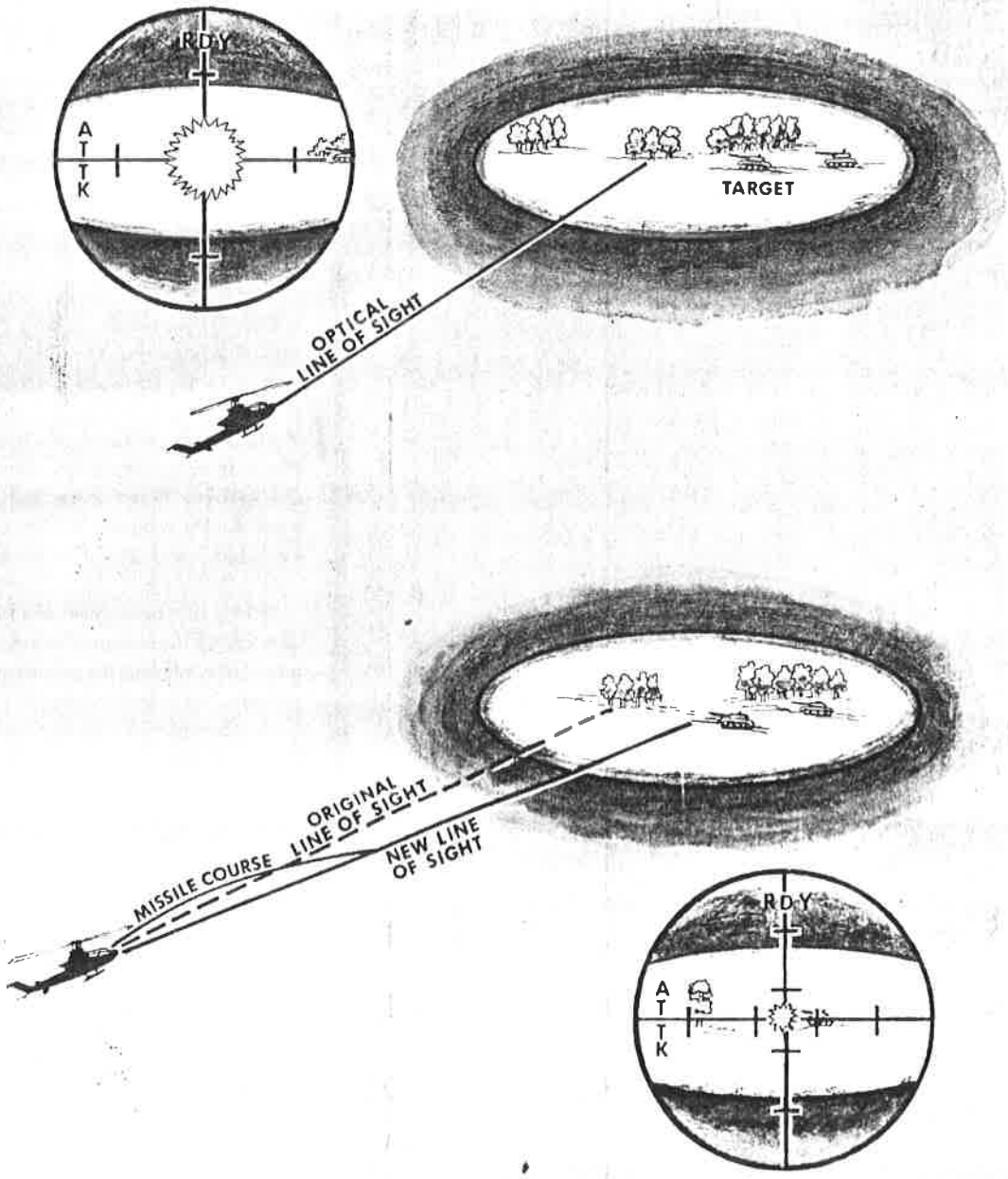
A knowledge of the capabilities and limitations of the TOW missile system discussed in this chapter is essential to insure that it is employed within the design characteristics of the system. When these limitations are exceeded, the probability of target kill is significantly reduced. Likewise, if the maximum capabilities of the system are not exploited, survivability of the aircrew and helicopter is reduced.

During the engagement of a target, aircrew teamwork is essential. Therefore, an aircrew that knows the assigned duties discussed in this chapter and executes its responsibilities effectively, reduces the exposure time during an engagement. Each aspect of this chapter provides the attack helicopter aircrew with essential information required to insure the destruction of enemy armor and the survivability of the helicopter. The degree to which the aircrew applies this basic knowledge will determine the success of the attack helicopter aircrew on the battlefield.

The first technique requires the gunner to follow the normal prelaunch tracking procedures. After the missile is fired, no further tracking corrections are applied until the target can be seen. This firing technique has the limitation that the correction required to bring the sight reticle on the target may exceed the maneuver capabilities of the missile. The pilot must hold a constant heading until the missile is downrange far enough so that the target can be seen through the TSU. When the gunner can see the target, he must make smooth deliberate corrections to bring the center of the sight reticle on the target.

A second technique that can be used requires the gunner to follow normal prelaunch tracking procedures. After the missile has been fired, he smoothly applies a tracking error that causes the missile to fly either left or right of the line of sight to the target. After the missile is beyond a range that the light intensity of the missile motor does not block out the target, the gunner slowly corrects to bring the center of the sight reticle back on the target.

The third technique is most preferable. It causes the missile to fly outside the target line of sight until it is beyond a range of approximately 1,000 meters, thus allowing the gunner to see the target throughout the flight of the missile. The gunner aligns the TSU on a point which is offset from the target. After the missile is fired, the gunner slowly applies correction to align the center of the sight reticle on the target. When employing this firing technique, the sight reticle should be offset to the side from which the missile is fired (i.e., if the missile is fired from the left side of the helicopter, the sight reticle should be displaced to the left of the target). The distance the center of the sight reticle is offset from the target should not exceed the limits of the TSU sight reticle.



CHAPTER TWO

HELICOPTER GUNNERY BALLISTICS

INTRODUCTION

Ballistics is the science which deals with the motion of projectiles and the conditions which affect that motion. The types of ballistics are *interior, exterior,* and *terminal.* An understanding of ballistics as discussed in this chapter is necessary for the aircrew of the attack helicopter to place effective fire on the target with the least expenditure of ammunitions.

INTERIOR BALLISTICS

Interior ballistics deals with the factors affecting the motion of the projectile within the tube. These factors affect the accuracy of all aerial-fired weapons and cannot be compensated for by the aircrew.

➡ *Tube wear.* Residues generated by burning propellant and movement of the projectile through the tube may either wear away the inner surface of the tube or cause deposits to build up within it. Either condition results in a loss of muzzle velocity and may induce excessive yaw.

➡ *Propellant charge.* Propellant charges for aerial weapons are fixed; however, there are minute differences in muzzle velocity and trajectory due to production variation. In addition, propellant burning is affected by temperature and moisture encountered in the storage environment.

➡ *Projectile weight.* Projectiles of the same caliber may vary within tolerance in weight. This is especially true in linked ball and tracer ammunition. The heavier projectile with all other factors remaining unchanged will have a lower velocity.

➡ *Tipoff.* Because the inside diameter of the rocket launcher tube is larger than the rocket, the rocket can exit the tube with an error in any direction. If, for example, the first rocket exits the tube pointing above the axis of the pod and the second exits the tube pointing right and down, the two rockets may move on divergent courses. When firing from a hover, relative wind cannot correct for this error; therefore, the rockets scatter more than those launched in forward flight.

➡ *Launcher tube alignment.* The launcher is composed of individual tubes which are replaced when excessive wear occurs. Alignment of the tubes is maintained by the end plates; however, accurate alignment of the tubes cannot be achieved. Because of variances in alignment, the boresight is only accurate for the tube that is used when boresighting the weapon to the gunsight. To minimize the error that is imparted to the rocket due to tube misalignment, armament personnel should check several tubes and select the one with the least alignment error to boresight the weapon.

EXTERIOR BALLISTICS

Exterior ballistics deals with the factors which affect the motion of the projectile as it moves along the trajectory. The trajectory is the path described by the center of gravity of the projectile as it passes from the muzzle of the weapon to the point of impact. Aerial-fired weapons have all the exterior ballistic factors associated with short-range, ground-fired weapons as discussed below plus other factors which are unique to helicopters as discussed below.

General Ballistic Factors

The exterior ballistic factors which affect all weapons systems are —

➡ *Air resistance (drag).* Drag is caused by the friction between the air and the projectile. It opposes and reduces the velocity of the projectile, causing it to fall short of its maximum range. Drag is proportional to both the cross-sectional area of the projectile and its velocity.

➡ *Yaw.* Yaw is the angle between the centerline of the projectile and the trajectory. Yaw causes the trajectory to change and increases drag. The direction of the angle of yaw is constantly changing in a spinning projectile. Yaw is at a maximum near the muzzle and gradually subsides as the projectile stabilizes.

➡ *Projectile drift (horizontal plane gyroscopic effect).* US projectiles, as viewed from the rear, spin in a clockwise direction. A spinning projectile acts as a

gyroscope and exhibits the characteristic known as *gyroscopic precession.* This force causes the projectile to precess, or move to the right. To compensate for this effect, it is necessary to aim to the left of the target. As the range increases, the effects of projectile drift increase, and more correction is required to cause the projectile to hit the target. The effect of projectile drift is compensated for when establishing combat sights or harmonizing the turret weapons. Gunners firing pintle-mounted weapons (door guns) must compensate for projectile drift by aiming to the left of the target.

➡ *Gravity.* The effects of gravity will cause an object to drop below its normal flightpath. The amount of drop depends on the time of flight (distance) to the target and the muzzle velocity of the projectile. The effect of gravity drop is corrected for when the turret weapons are harmonized. The mil setting on the sight card for the 2.75-inch FFAR compensates for gravity drop. When firing door guns, the gunner must apply correction for gravity drop to hit the target.

➡ *Wind drift.* Wind drift is the lateral movement of the projectile that is caused by a force acting on the projectile within flight. The amount of drift depends on the projectile's time of flight and the windspeed acting on the cross-sectional area of the projectile. Time of flight depends upon the range to the target and the average velocity of the projectile over this range. Firing into a crosswind requires that the weapons be aimed upwind to allow the wind to drift the projectile back to the target. For weapons systems which do not compensate for the effect of projectile drift, it may correct for wind drift or amplify the problem depending upon the direction the wind is acting upon the projectile. Firing into the wind or downwind will require no compensation laterally, but some adjustment is required in range.

Aerial Ballistics

The exterior ballistic factors peculiar to aerial-fired weapons are dependent upon whether the projectiles are spin-stabilized or fin-stabilized and whether they are fired from the fixed mode or the flexible mode. However, there are factors that are common only to helicopters, such as —

➡ *Rotorwash error.* Rotorwash is a force that is acting upon the projectile as it leaves the launcher, causing it to change trajectory. This condition occurs when operating below an airspeed of approximately 25 knots. At higher airspeeds, the rotor system is operating in clean air and the relative wind strikes the nose of the projectile. Although rotorwash affects the accuracy of all weapons systems, the 2.75-inch FFAR is affected the most. Maximum error is induced by

CORRECTIONS FOR GRAVITY DROP

Round	Muzzle Velocity (Ft Per Sec)	Range (Meters)	Gravity Drop Correction (Mils)	
7.62mm	2,750	1,000	7.05	0,18 mm
20mm	3,380	1,000	5.88	0,15
30mm	2,200	1,000	.00	
40mm	790	1,000	86.70	2,2

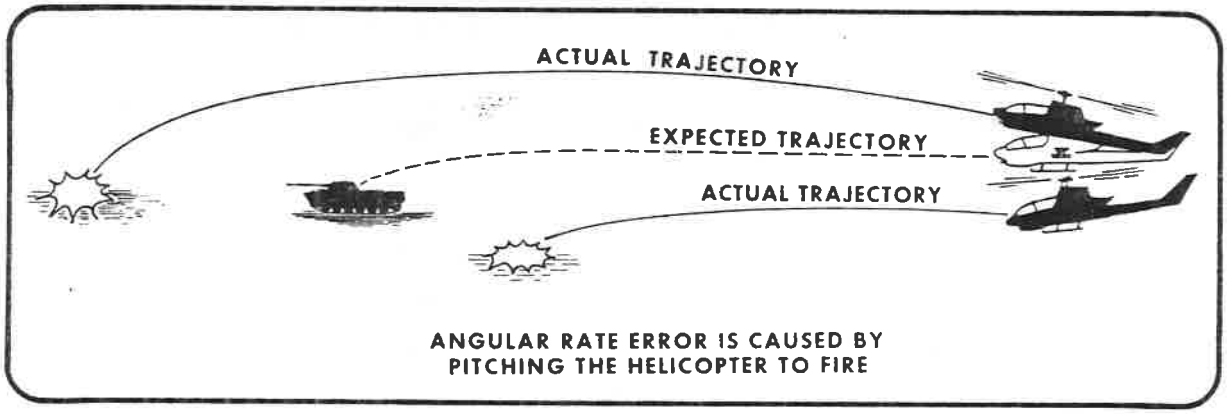
Table 2-1

the rotorwash when the weapons system is fired while hovering in-ground effect. During this condition, the flow of air is down through the rotor blades, causing the rocket to weathervane up as it leaves the launcher. When the rocket passes beyond the rotor disk, the flow of air changes to an upward flow. This condition produces an opposite effect on the rocket, causing it to wobble; thus inducing both lateral and linear error. By hovering out-of-ground effect, the relative wind strikes the rocket from only one direction (above) after leaving the launcher. This condition decreases the lateral error; however, because the velocity of the rotorwash increases due to the additional power required to maintain a hover out-of-ground effect, linear dispersion may be greater. This error is further increased during conditions of high density altitude and when the helicopter is heavily loaded. Aircrews should note the power required to maintain a hover when establishing gunsight setting; and when possible, use this power setting to fire the weapons. During both conditions of hover flight, rockets fired from the right side of the helicopter are affected more by rotorwash than rockets fired from the left side, and tend to land farther. To compensate for this condition, the QE of the right launcher must be lower than the left launcher.

➡ *Angular rate error.* Angular rate error is an error imparted to the projectile by the motion of the helicopter as it leaves the weapon. The effect of angular rate error is common to all weapons systems; however, the 2.75-inch FFAR is affected the most. For example, a pilot using the running fire delivery techniques to engage a target at 5,000 meters must pitch up the nose of the helicopter to place the gunsight reticle on the target. At the time the weapon is fired, an upward motion is imparted to the projectile by the movement of the helicopter. The amount of error that is induced is determined by the distance to the target, the rate of motion, and the airspeed of the helicopter prior to firing the weapon. Angular rate error also occurs when firing from a hover using the pitchup delivery technique, but to a lesser degree. Anytime a pitchdown motion is required to achieve the desired sight picture, the effect of angular rate error causes the projectile to land short of the target. The gunnery tables for the 2.75-inch FFAR compensate for the effect of angular rate error.

Aerial Ballistics of Spin-Stabilized Projectiles

There are certain aerial exterior ballistic factors peculiar to spin-stabilized projectiles fired from weapons with rifled barrels (e.g., 7.62mm, 20mm). When fired in the fixed mode (straight ahead of the helicopter), generally they have the same ballistic factors common to ground-fired weapons, except the relative wind

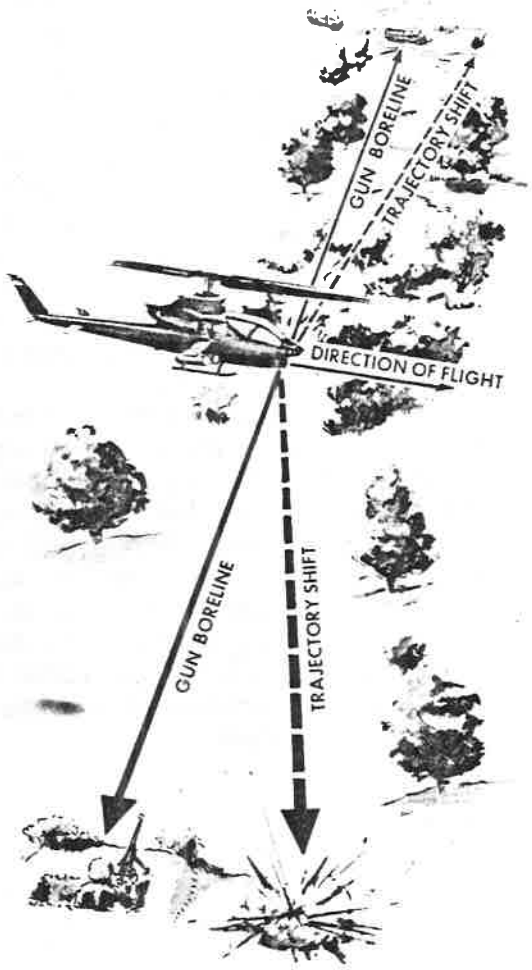


ANGULAR RATE ERROR IS CAUSED BY PITCHING THE HELICOPTER TO FIRE

changes and the velocity of the platform (helicopter) is added to the velocity of the projectile. The ballistic factors affecting spin-stabilized projectiles fired in the flexible mode are —

➡ *Trajectory shift.* When the boreline axis of the weapon differs from the flightpath of the helicopter, the forward velocity of the helicopter causes a change in the direction and velocity of the projectile. For deflection shots within 90° of either side of the helicopter heading, trajectory shift will cause the round to be left or right of the target when the gunsight is aimed at the target. Trajectory shift is corrected by leading the target (fire placed on the near side of the target as the helicopter approaches it). The amount of lead is dependent upon the airspeed of the helicopter, deflection angle, velocity of the projectile, and target range. Some typical lead angle values are shown below. Compensation for trajectory shift is not required when firing from a stationary hover.

Note. The attack helicopter is equipped with a system which automatically corrects for trajectory shift. When the system is activated, no compensation is required by the gunner.



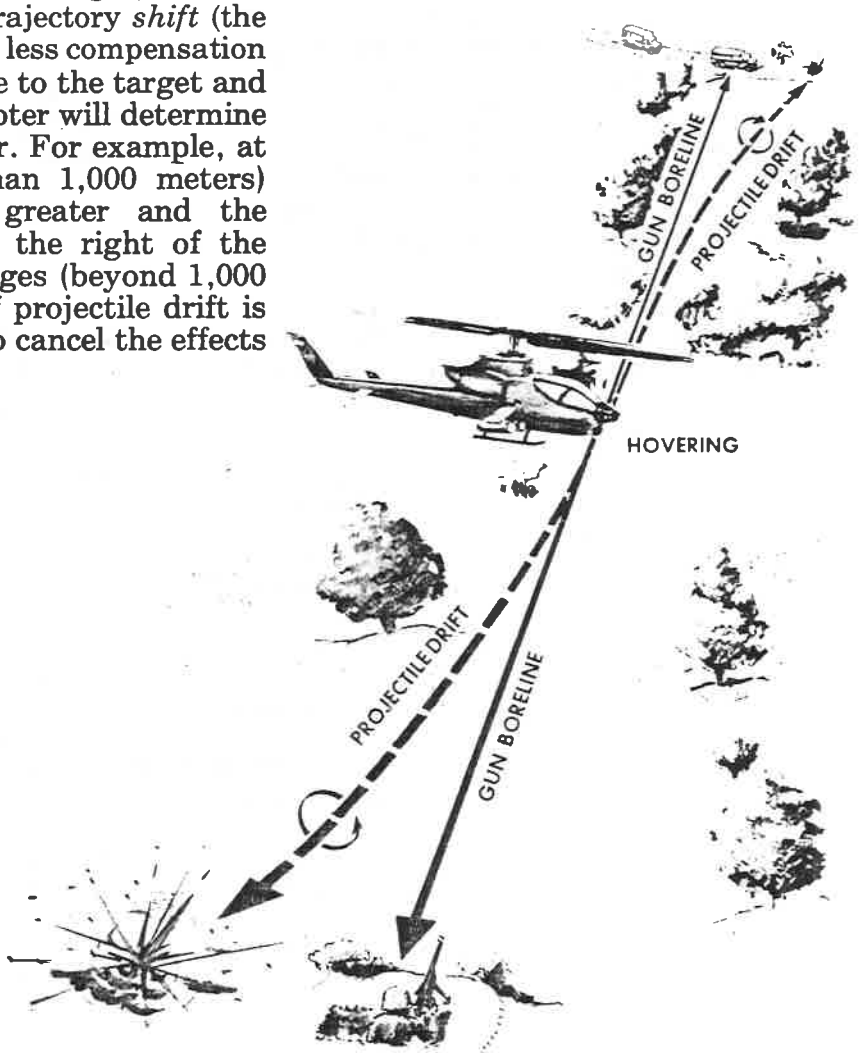
LEAD ANGLE VALUES
(60°Deflection at 1,000 Meters)

Round	Muzzle Velocity (Ft Per Sec)	Helicopter Velocity (Knots)	Lead Angle (Mils)
7.62mm	2,750	100/200	51/102
20mm	3,380	100/200	47/94
30mm	2,200	100/200	64/128
40mm	790	100/200	182/364

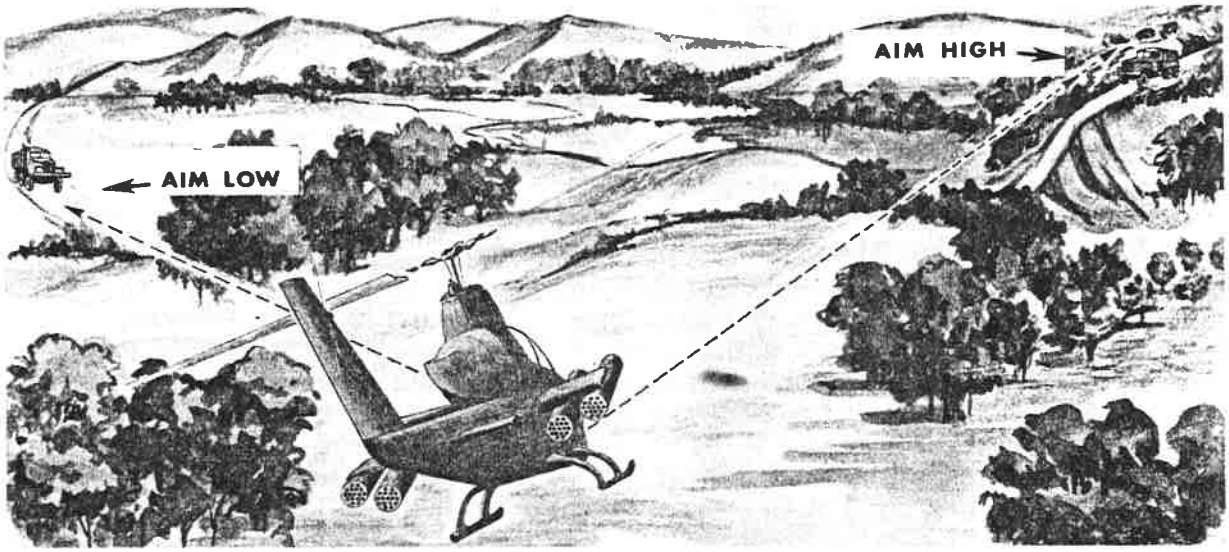
Table 2-2

➡ *Port-starboard effect.* When firing flex weapons, the effect of trajectory shift and projectile drift results in the port-starboard effect. When firing at targets on the portside (left), the effects of drift and shift compound each other because both effects are to the right. To hit the target with the weapons system, the gunner must apply correction for both ballistic effects by firing to the left (near side) of the target. When firing to the starboard (right) side, the effect of projectile *drift* (the round moves right) tends to cancel the effect of trajectory *shift* (the round moves left) and less compensation is required. The range to the target and airspeed of the helicopter will determine which effect is greater. For example, at close ranges (less than 1,000 meters) trajectory shift is greater and the gunner must fire to the right of the target. At longer ranges (beyond 1,000 meters), the effect of projectile drift is greater and it tends to cancel the effects of trajectory shift.

Note. The attack helicopter is equipped with a system which automatically corrects for trajectory shift and the effects of projectile drift are compensated for when the turret weapons are harmonized. Gunners firing pintle-mounted weapons (door guns) require compensation for the effects of both projectile drift and trajectory shift.



➡ *Projectile jump [vertical plane gyroscopic effect].* If a projectile is fired in any direction other than along the helicopter line of flight, an initial yaw due to the crosswind will be induced. A projectile elevation jump is produced that is proportional to initial yaw. When firing to the right, a downward jump is produced; when firing to the left, an upward jump is produced. A gunner must aim slightly above a target on the right side of the helicopter and slightly below a target on the left side. Compensation devices do not correct for this effect. The amount of compensation in the opposite direction from the jump required to correct for projectile jump increases as the helicopter velocity and angular deflection of the gun increases. Compensation for projectile jump is not required when firing from the hover position.



Aerial Ballistics of Fin-Stabilized Projectiles

The exterior ballistic factors affecting fin-stabilized projectiles are of major importance. These factors are —

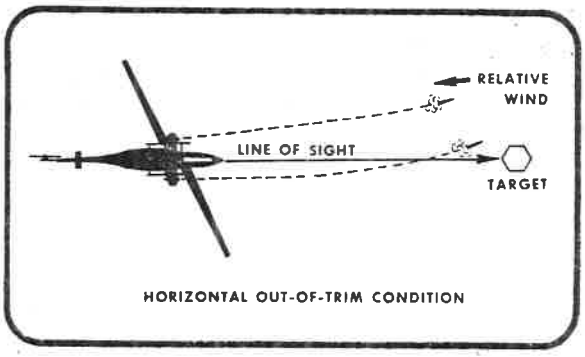
➡ *Propellant force.* A bullet has its maximum velocity at the muzzle; however, a rocket continues to accelerate until motor burnout occurs (approximately 1.7 seconds after launch). As the rocket reaches its greatest velocity, the kinetic energy that is contained in the rocket tends to overcome other forces and causes the rocket to travel in a straight line of flight.

Note. To provide equalization of thrust from exhaust nozzles, fin-stabilized rockets rotate approximately 15 revolutions per second. Since this is not sufficient rotation for significant gyroscopic precession or yaw, these factors may be ignored.

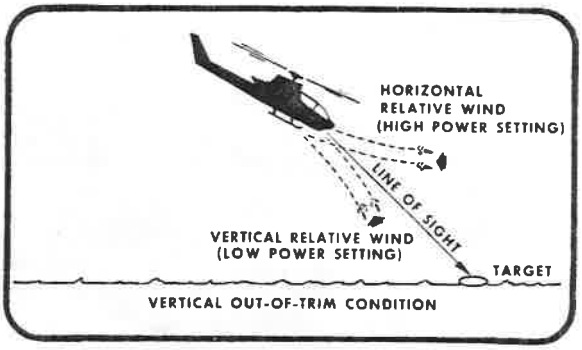
➡ *Center of gravity (rocket).* Unlike a bullet, the center of gravity of the rocket is in front of the center of pressure. As the rocket propellant is consumed, the center of gravity will move farther forward. The primary purpose of the fins is to insure that the center of pressure follows the center of gravity. A malfunction of the fins will cause the rocket to nose over, causing it to impact short of the target.

➡*Relative wind effect.* When the helicopter is flown out of trim either horizontally, vertically, or a combination of both as the rocket leaves the launcher, a greater crosswind component acts upon its surface area. Because the velocity of the rocket is the slowest during the burning phase of the trajectory, the force acting upon the fins will cause the nose to weathervane into the wind.

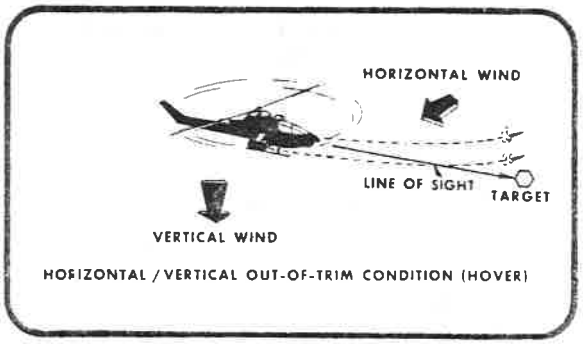
A horizontal out-of-trim condition is the result of the pilot's trying to align the gunsight on the target during a crosswind condition by cross-controlling (or slipping) the helicopter. For example, a helicopter that is flown at 100 knots while maintaining 10° out-of-trim with a quartering crosswind component of 10 knots will cause the rocket to turn about 4° into the relative wind after leaving the tube. As the velocity of the rocket increases, this turning effect decreases and the effect of wind drift influences the trajectory of the rocket. If the tactical situation does not permit the helicopter to be aligned into the wind, an upwind correction is applied on the gunsight to correct for a horizontal out-of-trim condition.



A vertical out-of-trim condition is the result of improper power setting which creates a vertical relative wind (up or down) on the rocket at launch. For example, a rocket fired while the helicopter is in autorotation has a relative wind from below the helicopter; it will weathervane into the relative wind and impact short of the target. If the rocket is fired while applying power, as in a climb, the relative wind is from above, and it will cause the rocket to hit beyond the target. To maintain a vertical trim condition, adjust to a power setting that will maintain a desired airspeed and altitude or rate of descent.



A combination of horizontal and vertical out-of-trim conditions can exist when the helicopter is firing in a crosswind while at a hover. The rotorwash produces a downward relative wind and the crosswind induces a horizontal relative wind. The effect of the resulting relative wind component on the rocket causes it to weathervane up and in the direction of the surface wind. Trajectory error caused by the relative wind cannot be accurately compensated for during the initial firing. Corrections are applied to hit the target after observing the impact of the projectile.



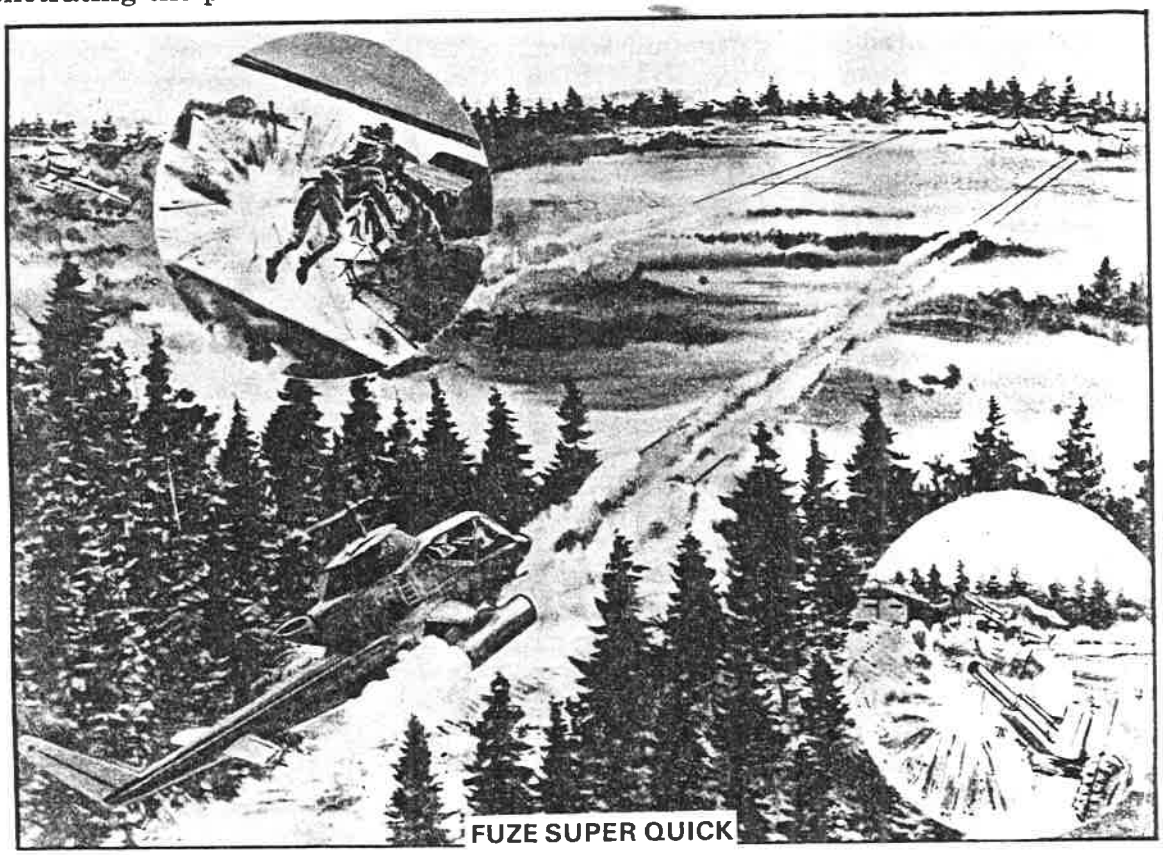
TERMINAL BALLISTICS

Terminal ballistics concerns those factors which affect the projectile at the target. Projectile functioning (i.e., blast, heat, fragmentation) is influenced by fuze functioning and warhead, angle of impact, and surface condition.

➡ *Impact fuzes.* Impact fuzes are designed to achieve surface and subsurface burst effect of the warhead. The type target being engaged and the protective cover afforded the target will determine the best fuze to be used. Targets that are in the open (e.g., personnel, vehicles, logistical complexes) should be engaged with a fuze (quick) which causes the warhead to detonate upon contact. Targets that have overhead protection (e.g., fortified positions, heavy vegetation) should be engaged with a fuze (delay) that causes the warhead to detonate after penetrating the protective cover.

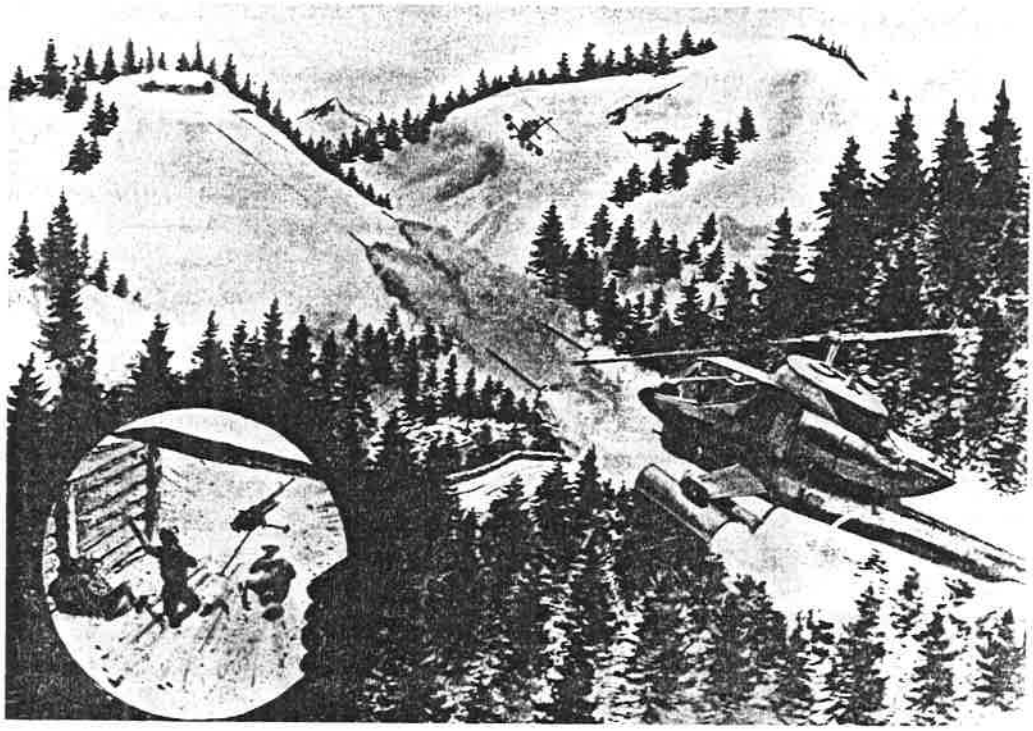
➡ *Preset fuzes.* Timed fuzes are designed to produce airburst and are best employed against targets which have no overhead protection. The flechette warhead incorporates a time fuze based on motor burnout. Range for this type of fuze is fixed. Manual set and electrical set time fuzes are being evaluated for use with submunitions, smoke, flare, and chaff warheads.

➡ *Surface conditions.* The surface (e.g., sand, rock, vegetation) of the target area will affect the lethality of the projectile. If superquick fuzes are employed in terrain cover with heavy foliage, the fuzes will function high in the tree canopy with little or no lethal effect at ground level. The same fuze could effectively be employed against a target area with a sandy surface. To achieve maximum lethality from the warhead, the proper fuze for the type surface condition must be used.



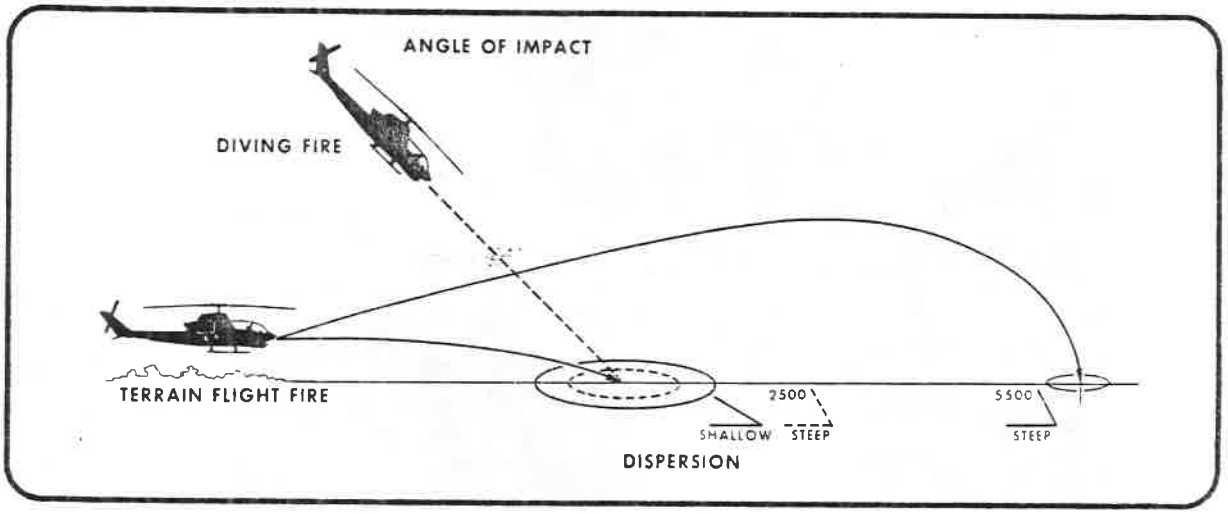
FUZE SUPER QUICK

FUZE DELAY



➡ *Warheads.* The type of target which will be engaged will determine which warhead is most effective. The high explosive (HE) warhead is considered to be the best all-purpose round. It can be armed with both types of impact fuzes and is effective against targets with and without overhead protection. Armor targets and heavy fortifications are best engaged with the high explosive anti-tank (HEAT) round. Special purpose warheads (e.g., smoke, flare, incendiary) are being developed for special use.

➡ *Angle of impact.* The altitude the projectile is fired from and the range to the target will determine the angle of impact and affect the fragmentation



pattern. Weapons fired while in a dive produce fragmentation patterns which are close together. When firing from NOE altitudes at the midrange of the weapon, an elongated pattern is formed with the projectile impacting at shallow angles. As the range increases, the impact angle of the projectile is increased and the size of the fragmentation pattern decreases.

DISPERSION

If a number of projectiles are fired from the same weapon with the same settings in elevation and deflection, the point of impact of the projectiles will be scattered both laterally (in deflection) and longitudinally (in range) about the mean point of impact of the group of rounds. The degree of scatter of these rounds in range and deflection is called dispersion. The location of the mean point of impact with respect to the target center (or the intended aim point) is an indication of the *accuracy* of the weapon. Both of these factors, dispersion and accuracy, will determine the ability of a particular weapon to hit an intended target. Dispersion is minimized and accuracy is optimized when firing the 2.75-inch FFAR near maximum ranges; whereas when firing other weapons systems, as the range increases, dispersion and accuracy decrease. Dispersion is caused by errors inherent in firing the projectile. These errors are caused, in part, by —

➡ *Interior ballistics.* Muzzle velocity is affected by minor variations in weight, moisture content, and the temperature of the propellant charge; variations in the arrangement and content of the powder grains; differences in the ignition of the charge; differences in the weight of the projectiles; and variations in the temperature of the bore or tube.

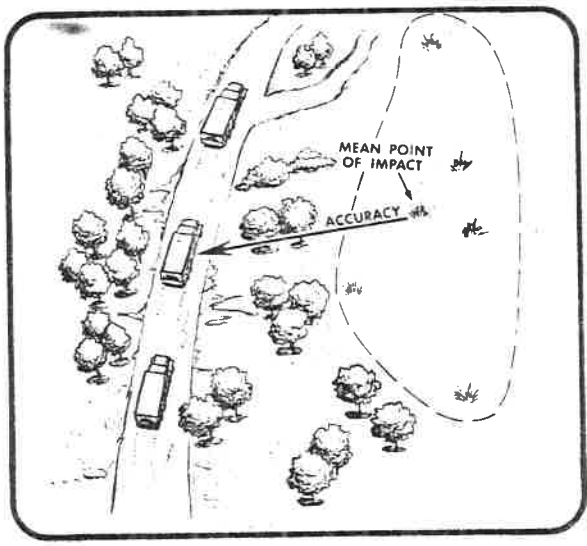
➡ *Conditions in the mount.* Deflection and elevation are affected by looseness in the mechanism of the mount and unequal reaction to firing stresses.

➡ *Vibrations in the mount.* Since the mount is fixed to the helicopter, vibrations in the helicopter are transmitted through the mount and affect both deflection and elevation.

➡ *Gunsights.* The condition of the gunsights and how accurately they have been aligned with the bore axis of the weapons will affect the dispersion of the projectiles. Special care must be taken to protect the gunsights and to accurately harmonize and determine combat sights.

➡ *Exterior ballistics.* From round to round, air resistance (drag) is affected by differences in weight; velocity; form of projectile; and changes in wind, air density, and temperature.

➡ *Terminal.* Targets engaged at close ranges from terrain flight altitudes have a very low angle of impact, causing large dispersion patterns.



Note. The dispersion of projectiles fired from the helicopter is significantly affected by the failure of the aircrew to compensate for external ballistics and poor delivery techniques. Dispersion caused by the aircrew can only be corrected by conducting frequent helicopter gunnery training.

SUMMARY

To effectively employ the weapons systems of the attack helicopter, aircrews must have an understanding of the factors of helicopter gunnery ballistics. Three types of ballistics are discussed within this chapter. The first is *interior ballistics* which deals with factors which adversely affect the accuracy of the weapon before it leaves the tube. These inaccuracies are induced by variation in manufacturing tolerances of ammunition and wear of the weapons caused by continual usage. Errors caused by interior ballistics cannot be compensated for by the aircrew.

Exterior ballistics error is the second ballistics factor that adversely affects the accuracy of the weapon. It deals with the factors which affect the projectile as it moves along its trajectory. There are certain general exterior ballistics factors that are common both to ground and aerial projectiles; however, there are aerial factors which only affect projectiles fired from a helicopter. Additionally, there are certain aerial exterior ballistics factors that are peculiar to spin-stabilized and fin-stabilized projectiles. The error that is caused by exterior ballistics can be compensated for by the gunner if proper corrections are applied. Some weapons systems automatically apply a correction factor for certain ballistics errors.

The third type of ballistics error affecting the accuracy of the weapon is *terminal ballistics*. In most cases, the aircrew cannot compensate for the effects of this error; however, proper selection of a warhead and fuze will increase the effectiveness of the weapons system.

The effect of each type of ballistics error combined produces what is referred to as dispersion. This is the degree of scatter of the projectile in both range and deflection about a target. To reduce the amount of dispersion, the aircrew must understand the effects of helicopter gunnery ballistics error and apply proper correction to hit the target.

CHAPTER THREE

PREPARATION FOR FIRING

INTRODUCTION

The attack helicopter is an essential element of combat power for the force commander. To maximize the effectiveness of the attack helicopter, aircrews must be proficient with the weapons systems with which it is equipped. The attitude of aircrewmembers to adjust the fire of the weapons by "hosing down" the target should not be used.

First-round hits to destroy the target with minimum expenditure of ammunition must be the goal of every aircrew. To achieve this goal, aircrews must be fully aware of the special considerations discussed in this chapter. Furthermore, the weapons systems and gunsights must be properly prepared. This chapter discusses the procedures for boresighting; harmonization for flex weapons; establishing combat sight setting; determining ballistic correction; and introduces sighting techniques.

SPECIAL CONSIDERATIONS

➡ *Units of measurements.* For a projectile fired from a helicopter weapons system to impact at the desired point, data is required on the direction, horizontal or slant range, speed of the helicopter, and sight setting. Although the unit of angular measurement most commonly used for helicopter navigation is the degree (17.8 mils), it is too large a unit for the aiming of weapons. The principal unit of angular measurement for aiming weapons is the mil. At 1,000 meters, an angular deflection of 1 mil results in a deflection distance error of 1 meter. Due to altitude, airspeed, and angle of attack, an elevation or depression error of 1 mil results in varying distances of error at 1,000 meters.

➡ *Adjusting tracer fire.* When firing tracer munitions, the gunner initially aims the weapon with the gunsight. After the initial burst impacts, the gunner should remove his eye from the gunsight and visually adjust fire on the target using tracers and burst-on-target effect to bring the point of impact on the target. Because the gunsight restricts the gunner's ability to observe the tracer and degrades his depth perception, visual adjustment of tracers onto the target is more accurate and places effective fire on the target sooner.

➡ *Sensory illusions.* Sensory illusions are the disturbances of an individual's equilibrium, and are caused by a discord of sensations coming to the brain from the eye and the internal ear. These sensations usually occur when there is no visual horizon for the pilot to remain oriented while maneuvering the helicopter (e.g., flying under instrument conditions). It may occur when rapidly changing the field of view from outside to inside, and vice versa. Sensory illusions are more easily induced at night because visual references are difficult to see. To protect against the possible loss of equilibrium, it is advisable that the crewmember not firing the weapon maintain a cross-check on the instruments during target attacks at night.

➡ *Target fixation.* Target fixation is a condition that may occur when conducting diving fire or running fire. It results in the loss of appreciation for speed, rate of closure, altitude, and other external stimuli. This condition can normally be avoided by practicing constant division of attention, even during target attacks.

➡ *Coordination.* Coordinated flight is important in aerial gunnery. An "out-of-trim" condition increases dispersion, thus reducing the effectiveness of the weapon. Emphasis must be placed on selection of firing points which take advantage of the wind condition, rather than using uncoordinated flight to obtain the sight picture. A common tendency is to cross-control, using the antitorque pedals to get the proper sight picture.

➡ *Control touch.* Rough and abrupt control movements result in unacceptable dispersion patterns. All movements should be a continuous application of control pressures rather than abrupt movements.

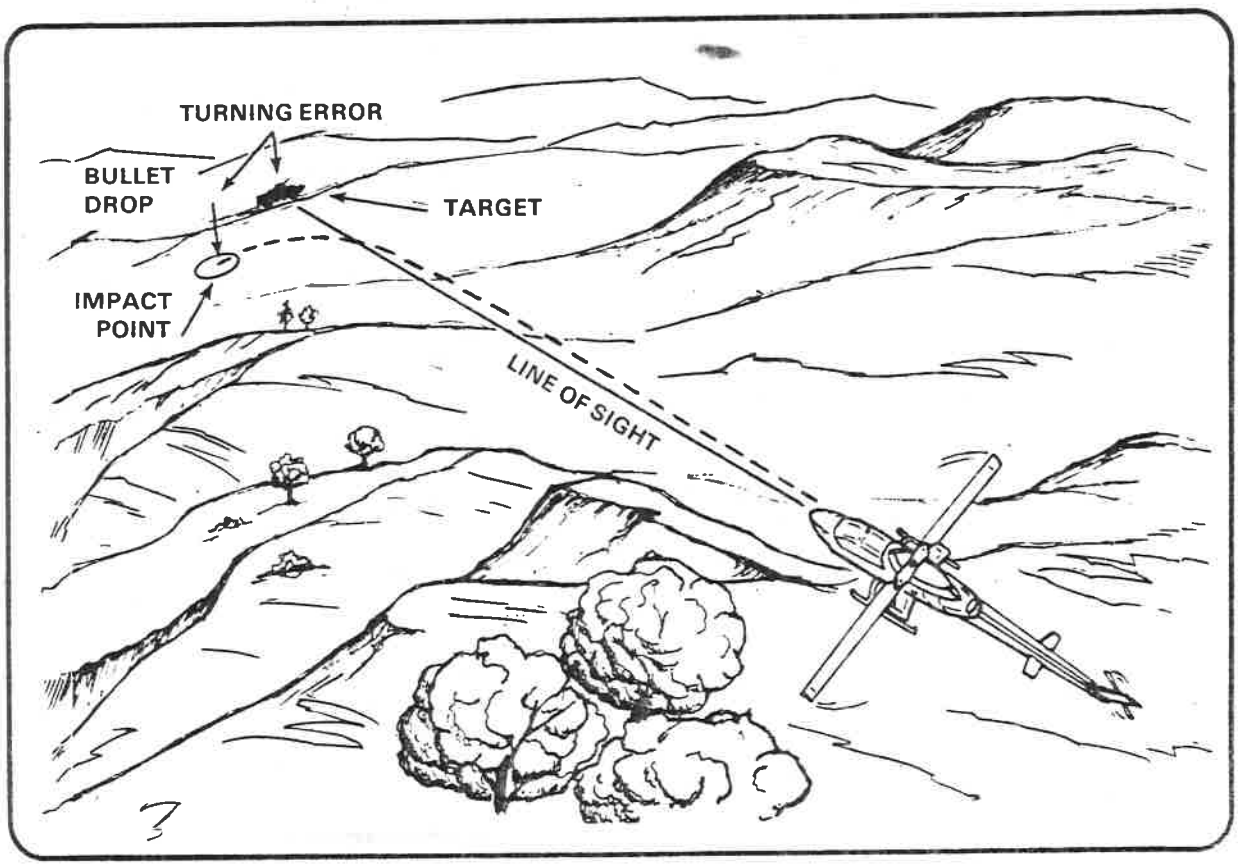
➡ *Parallax.* Parallax is the apparent displacement of an object due to a change in range and viewpoint. It is caused by a misalignment of the lens and can result in serious errors in gunnery. The M73 and turret reflex gunsight on the AH-1 helicopter correct for parallax.

➡ *Turning error.* Firing while in a bank affects both stowed and flexible weapons fire. If the weapon is fired while the helicopter is in a bank, what is normally deflection becomes elevation. Firing results in rounds impacting short and inside the turn. To compensate for turning error, it is necessary to aim high

and opposite to the direction of the bank.

➡ *Range.* Range may be expressed either as horizontal range (horizontal distance from a point on the ground below the helicopter to the target) or slant range (range from weapons to the target). Range is expressed in meters and may be measured graphically, measured electronically, or estimated. The range of any projectile is a function of the muzzle velocity (or terminal velocity for rockets) and the elevation of the tube. Elevation for helicopter gunnery using direct fire techniques is measured using the waterline of the helicopter as zero. When using indirect fire techniques, the zero setting is a standard attitude which results from one-half loading of the turret weapons. Deviation above or below these positions is positive or negative.

➡ *Direction to the target.* Direction is expressed as a measurement from a reference direction, usually magnetic north. A direction to a target or an attack heading can be expressed in degrees. When using degrees, direction is usually given in 5° increments. Directions may also be expressed as a cardinal compass point (e.g., 360° N, 180° S). Between aircrews, the clock method of expressing headings is most commonly used for locating targets, positions, etc. Target direction is measured clockwise from the nose of the helicopter which is the 12 o'clock position. To more rapidly identify a target, direction will usually be combined with range or a polar plot. For example, target heading, 080°; range, 1,500 meters, or "ZSU-23 at my 3 o'clock; range 500."



➡ *Attitude changes.* When a change in airspeed or aircraft center of gravity (C.G.) occurs, an attitude change results. When firing stowed weapons, the accuracy of the weapon is reduced when flight attitude changes occur. For example, if a target is engaged with the turret weapon in the stowed mode at a hover with a fully loaded turret and the same target is engaged at 60 knots with the same turret load, the rounds would impact beyond the target. Similarly, if the same target were engaged at a hover with only a half turret load of ammunition, the rounds would impact short of the target. To minimize the effect of attitude error, the sight setting should be determined at the range, airspeed, and C.G. condition that the greatest number of targets will be engaged. The effect of attitude error for the various airspeeds is compensated for in the 2.75-inch FFAR sight card. However, to achieve a high degree of accuracy, the standard loading must be maintained or corrections made to compensate for nonstandard turret loading. The effect of attitude error is greatest when using the attitude indicator to determine the firing attitude for indirect fire using the 2.75-inch FFAR.

RANGE ESTIMATION

To effectively employ the attack helicopter, the aircrew must be capable of determining the range to the target. Inaccurate range estimation results in rounds missing the target and alerts the enemy to a pending attack, thus reducing the effectiveness of surprise. To accurately estimate range, aircrews must train to estimate range. The methods of determining range are estimation by eye, sight mil values, tracer burnout, map and photomaps, and electronic devices.

➡ *Visual range estimation.* The most common method for determining range is estimation by eye. Normally, this method is more accurate when the range is compared to known ranges, i.e., the number of 100-meter segments there are in the range. While this method is most rapid, it is also the least accurate.

COMMON CAUSES OF INACCURATE VISUAL RANGE ESTIMATION

Nature of the Target

A target in contrast to its background appears closer.

A target that blends with its background appears more distant.

A target that is partially hidden appears more distant.

Nature of the Terrain

Over smooth terrain, the eye tends to underestimate the range.

Over rough terrain, the eye tends to overestimate the range.

Visibility

A target seen in full sunlight appears closer than one observed through haze or fog.

When the sun is behind the target, the target appears more distant than it actually is. When the sun is behind the observer, the target appears closer.

➡ *Tracer burnout.* Because the 7.62mm round of tracer ammunition burns out at a range of approximately 900 meters, the gunner can use tracer burnout to make a range estimate. If the tracers burn out before reaching the target, the 900-meter tracer burnout distance can be compared to the total distance to the target. For example, the gunner fires a burst of 7.62mm tracer ammunition that burns out halfway to the target. Thus, it is estimated that the range to the target is approximately 1,800 meters.

➡ *Maps and photomaps.* Prior to and during the mission, ranges from prominent terrain features to the target area may be determined from maps and photomaps. This permits comparison of actual ranges with ranges estimated by eye and is very useful in teaching aviators to correctly estimate ranges visually. This is the primary method of determining ranges when operating in a high threat environment. It allows the aircrews to accurately determine the range to the target without exposing the helicopter to the enemy. The use of maps and photomaps at night is more restrictive due to the limited range terrain features can be identified.

➡ *Electronic devices.* The most accurate means of determining range to the target is with electronic devices. A newer generation of attack helicopters is being equipped with laser range finders. This equipment will provide the aircrew fast and accurate range information which will improve the first-round-hit capability for aircrews of the attack helicopter.

➡ *Sight mil values.* Because of the vibration caused by helicopters, reading the mil values of target width in the gunsight is difficult. However, if this value can be determined and the target width is known, the mil value for target width can easily be converted to the range. At a range of 1,000 meters, 1 mil equals 1 meter; therefore, if target width is known, range can be found by using the following formula:

$$R = \frac{W}{m} \text{ x } 1{,}000 \text{ meters}$$

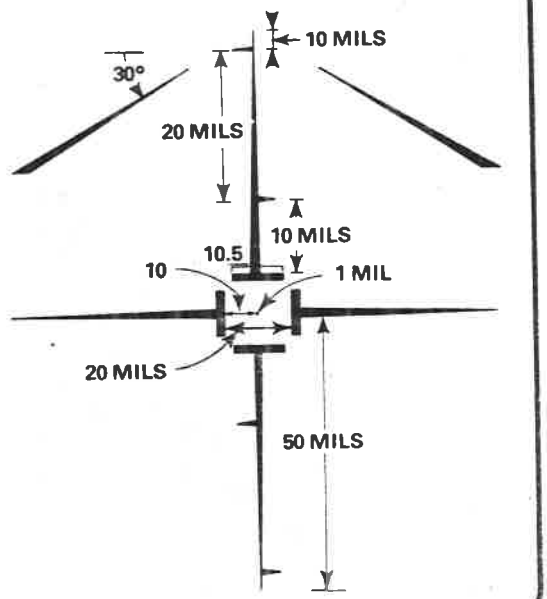
R = range (meters)
W = known target width (meters)
m = mil value of target width (meters)

For example, a tank known to be 15 meters long covers 20 mils of reticle width. Range to the tank is 750 meters.

$$R = \frac{15 \text{ meters x } 1{,}000 \text{ meters}}{20 \text{ mils}}$$

$$R = 750 \text{ meters}$$

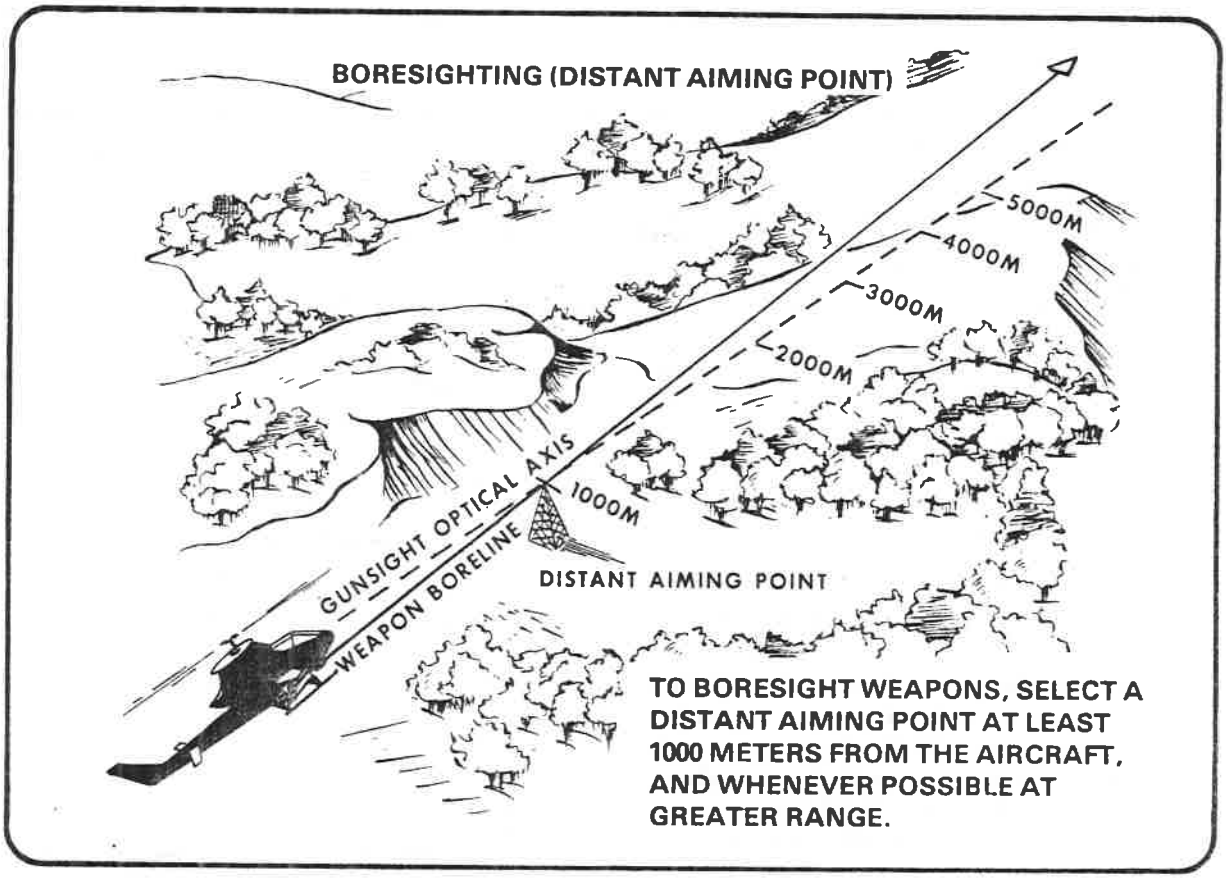
RETICLE IMAGE FOR M73 REFLEX SIGHT



BORESIGHTING

Boresighting is the initial step in adjusting each armament subsystem and the gunsights to insure that the aiming point and the impact point of the projectile are the same. It is the process by which the horizontal and vertical boreline axis of the weapon and the optical axis of the gunsight are made parallel to each other or converge at a distant point, depending on the method used. Boresighting does not compensate for deviations due to ballistic factors previously discussed. The final step is to fire the weapon and make adjustments so that the aiming point and the point of impact of the projectile are the same. These procedures are discussed later in this chapter. Depending upon the facilities and time available, either the distant aiming point or parallel line is prescribed for boresighting helicopter armament subsystems.

➡ *Distant aiming point.* The most commonly used method is the distant aiming point. This method has the advantages that a mechanical aiming point is not required and less time is required to perform the boresight. Using this method, an aiming point is selected at a distance no less than 1,000 meters from the helicopter. When boresighting rocket launchers, the aiming point should be at a range where most of the targets will be engaged. Targets that are engaged short or beyond the range of the aiming point will result in the rockets crossing, and greater dispersion will occur.

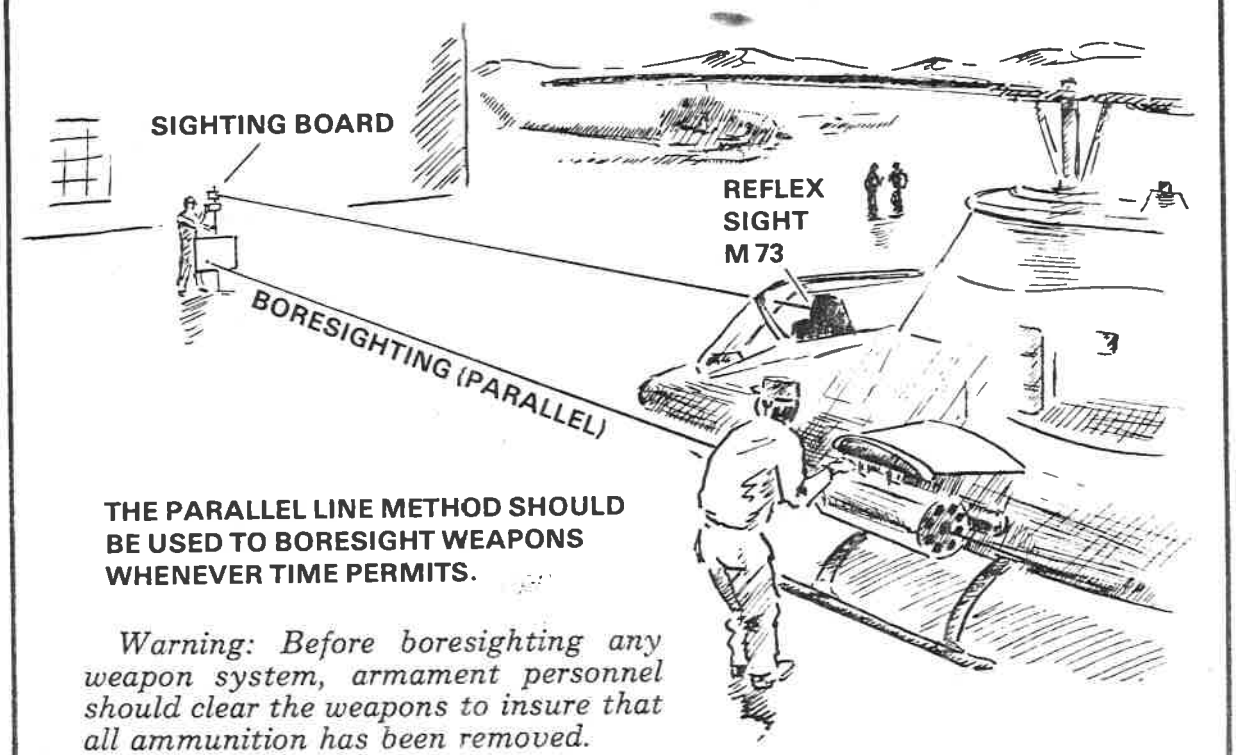


➡ *Parallel line.* The parallel line method is the most accurate method for boresighting. It uses a sighting board with measured aiming points for the gunsight and each weapon system to sight on. This method has the advantage that it can be performed in a relatively small area (e.g., maintenance hangars, tactical sites). Each weapon and gunsight is aligned with measured points on the sighting board. The axes of the weapons do not converge when using the parallel line method.

A detailed description of the procedures for boresighting is contained in reference publications for the type helicopter and weapon subsystem. Normally, armament personnel are responsible for boresighting; however, aircrews may be required to assist. The basic requirements for boresighting are as follows:

➡ The helicopter should be leveled and the gunsights set at zero elevation. (When boresighting the M35 armament subsystem, -43 mils is placed on the M73 gunsight.) The turret gunsight should be centered. Align the gunsight reticle with the aiming point. When using the distant aiming point method, the helicopter must be moved to align the sight reticle with the aiming point. If the parallel line method is used, the sighting board is moved to align the sight reticle with the aiming point.

➡ Insert boresight adapter into muzzle of barrel and visually view the aiming point through the optical lens. Adjust elevation and/or azimuth boresight adjustments until telescopic crosshairs are on the aiming point. (When boresighting the rocket launcher, only the azimuth crosshair is aligned on the target.)



THE PARALLEL LINE METHOD SHOULD BE USED TO BORESIGHT WEAPONS WHENEVER TIME PERMITS.

Warning: Before boresighting any weapon system, armament personnel should clear the weapons to insure that all ammunition has been removed.

HARMONIZATION

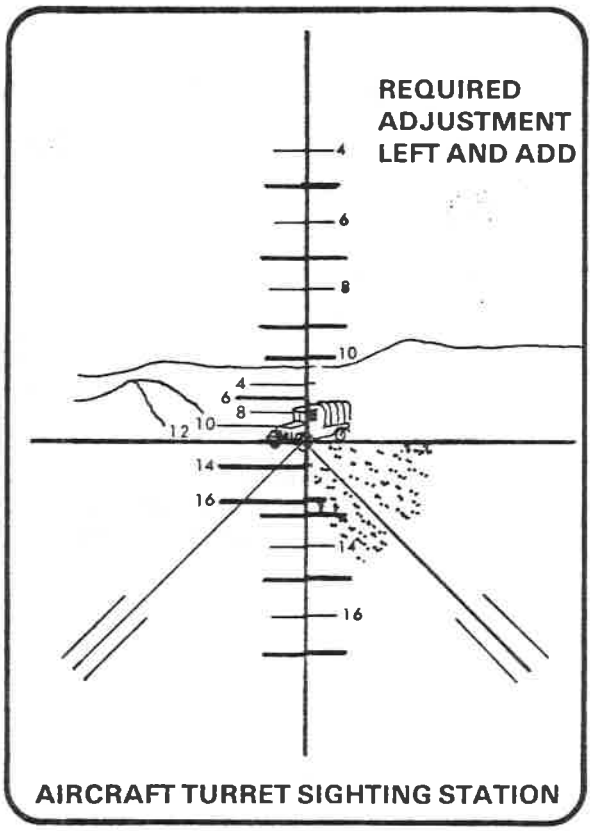
After the turret weapons have been boresighted, they must be fired to determine the point of impact in relation to the target depicted on the gunsight. The process of adjusting the turret guns to hit where the gunsights are aimed is harmonization. After the weapons have been harmonized, the gunner can accurately engage targets within the range scale of the gunsight. It is not necessary to harmonize both turret guns with the gunsight. When one weapon is adjusted, a correction is applied to the second gun which aligns it with the gunsight. Normally, the 7.62mm machinegun is harmonized. Harmonization can be conducted during running fire, at a hover, or while sitting on the ground. The most accurate method is to harmonize while the helicopter is positioned on the ground.

Harmonization Procedures

Select a target approximately half the distance of the maximum effective range of the weapon or the range which the majority of targets will be engaged. Place the gunsight on the target with the appropriate range line on the target and fire a 3-second burst.

Observe the strike of the projectile and adjust the weapon system for elevation and azimuth error using the sight resolvers. A clockwise movement of the elevation and azimuth resolvers will move the strike of the bullet up and left, respectively.

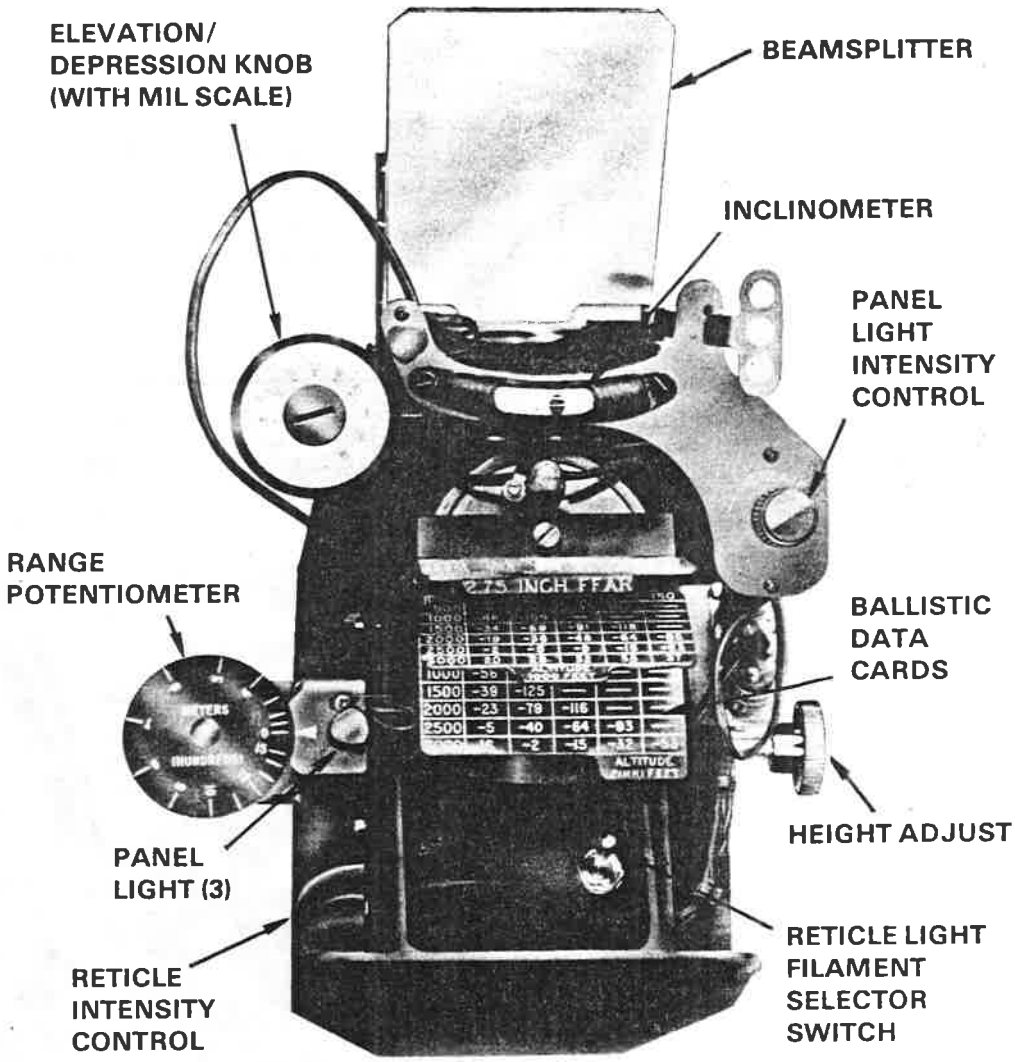
A second burst should be fired to verify the correct setting on the weapon. When the burst impacts on the target, the guns and gunsight are harmonized.



AIRCRAFT TURRET SIGHTING STATION

COMBAT SIGHT SETTING/ BALLISTIC CORRECTION

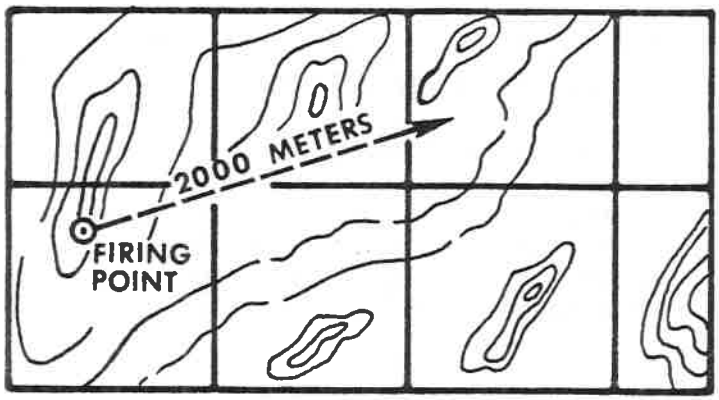
After stowed weapons have been boresighted, they must be fired while in flight to determine the point of impact of the projectile in relation to the sight picture depicted on the gunsight. The adjustment of the gunsight to compensate for trajectory errors, which cause the projectile to miss the target, is referred to as combat sight setting when conducting diving fire and ballistic correction for terrain flight firing. The following are recommended procedures for determining the combat sight setting and ballistic correction using the M73 gunsight.

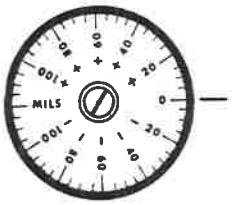


REFLEX SIGHT M 73

Diving Fire

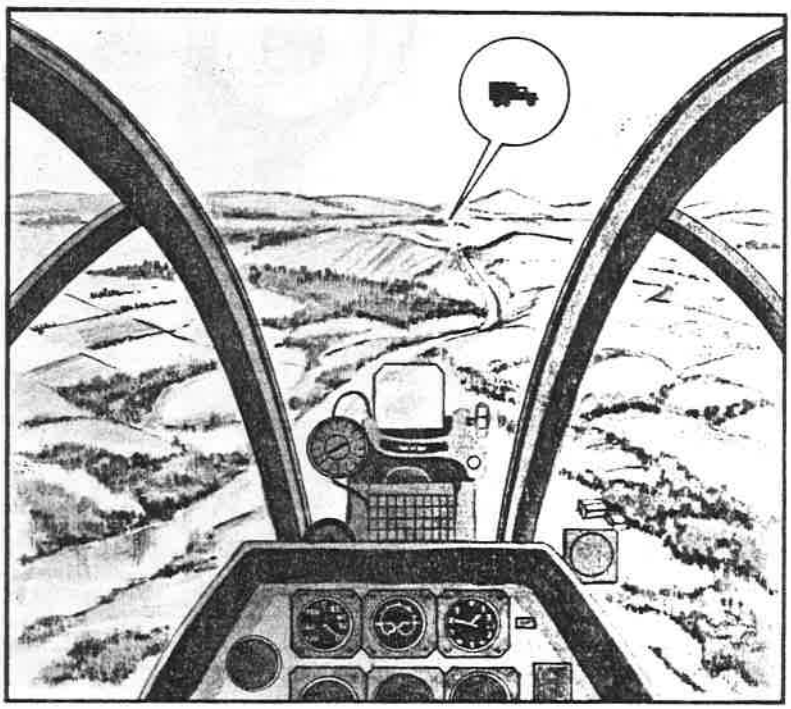
Select a target at a distance where the most targets will be engaged. For diving fire, 2,000 meters is normally used. Set the mil scale on the gunsight to zero.



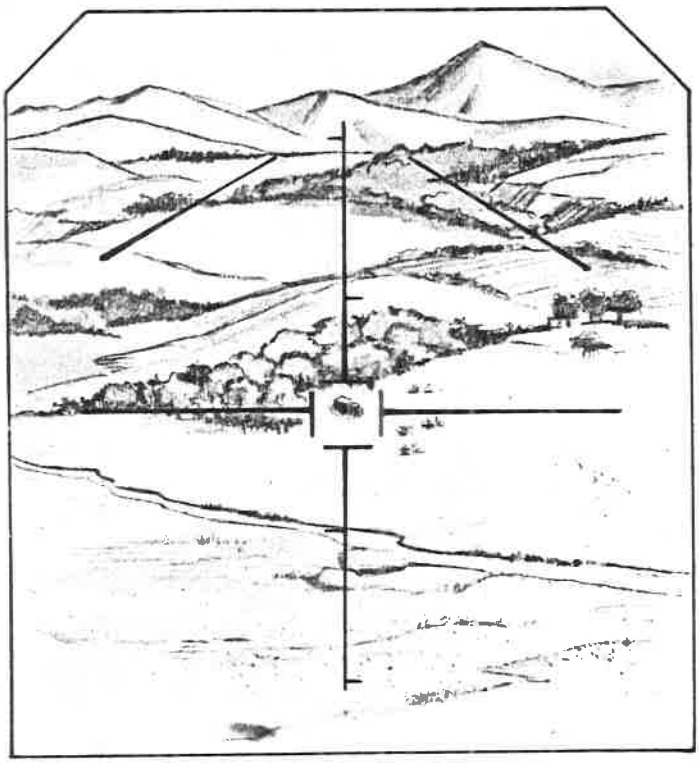


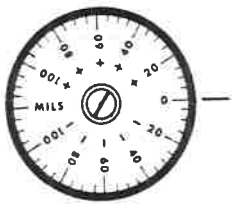
ELEVATION/DEPRESSION KNOB

Before reaching the roll-in point, the helicopter should be 80 knots indicated airspeed (IAS) at an altitude of 1,600 feet above ground level (AGL).

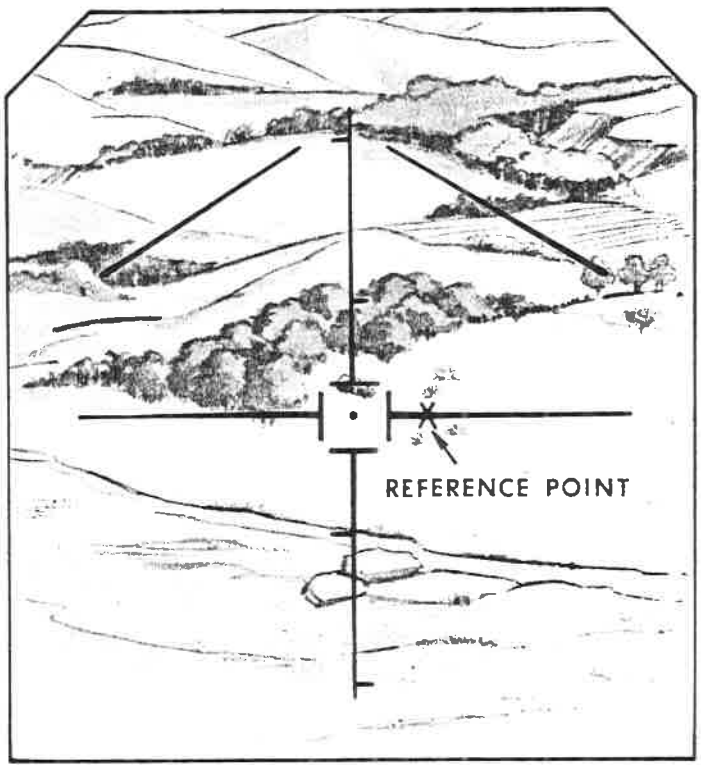


With the proper power setting and the helicopter in trim, intercept a 12° to 15° dive angle to the target. Adjust controls as necessary to establish vertical and lateral trim. The reticle on the gunsight should be aligned with the target so that the center of the reticle image (pipper) is positioned over the target. At approximately 1,200 feet AGL and 120 knots IAS (1,500 meters slant range), fire one pair of rockets or a 3-second burst of the 20mm gun. The sight picture must be maintained until the rockets impact.

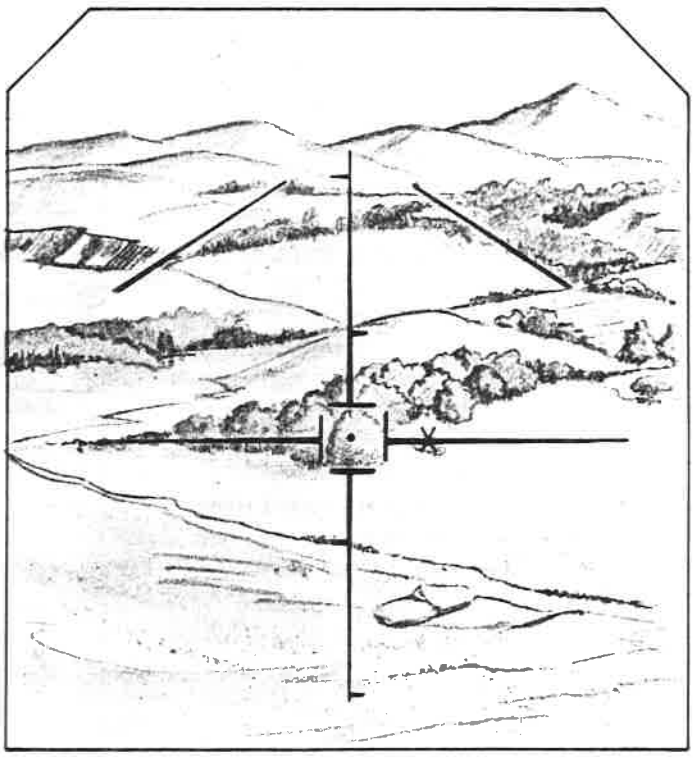




Note the point of impact and rotate the elevation/depression knob on the gunsight until the horizontal crosshair of the sight reticle is superimposed over the point of impact. Lateral error cannot be compensated by moving the reticle image. The pilot must mentally note the position of the impact point along the horizontal crosshair or mark a reference point at the point of impact on the gunsight.



A second firing should be conducted to confirm the combat sight setting. The flight maneuver is performed as previously discussed; however, the sight picture changes. The horizontal hairline is superimposed over the target so that the reference mark or a point where the pilot mentally visualizes the lateral correction is over the target. When the rockets impact on the target, the combat sight setting has been established.



Terrain Flight Firing

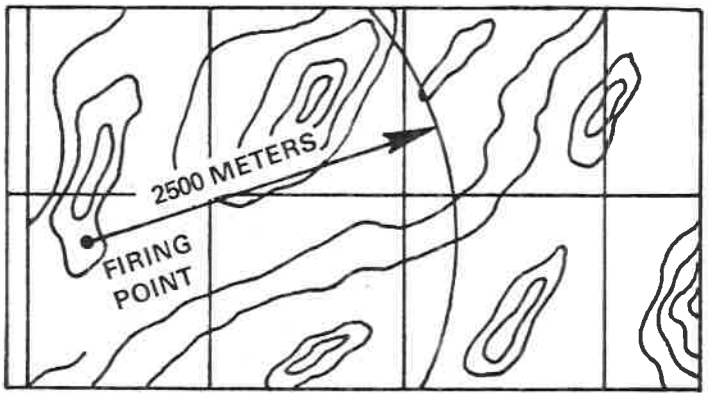
The procedures used to determine an accurate sight setting for terrain flight firing are not the same as determining a combat sight setting for diving fire. The primary difference between the two modes of delivery is that a sight card containing mil settings for specific conditions of flight and ranges is used to determine the mil setting on the gunsight for terrain firing. To this value, a ballistic correction factor is applied which compensates for meteorological conditions and interior ballistics for the individual weapon as these conditions affect range.

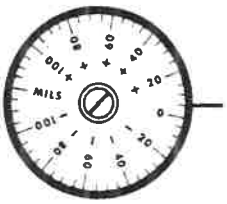
WHEN USING THE M73 GUNSIGHT USE THE SIGHT CARD

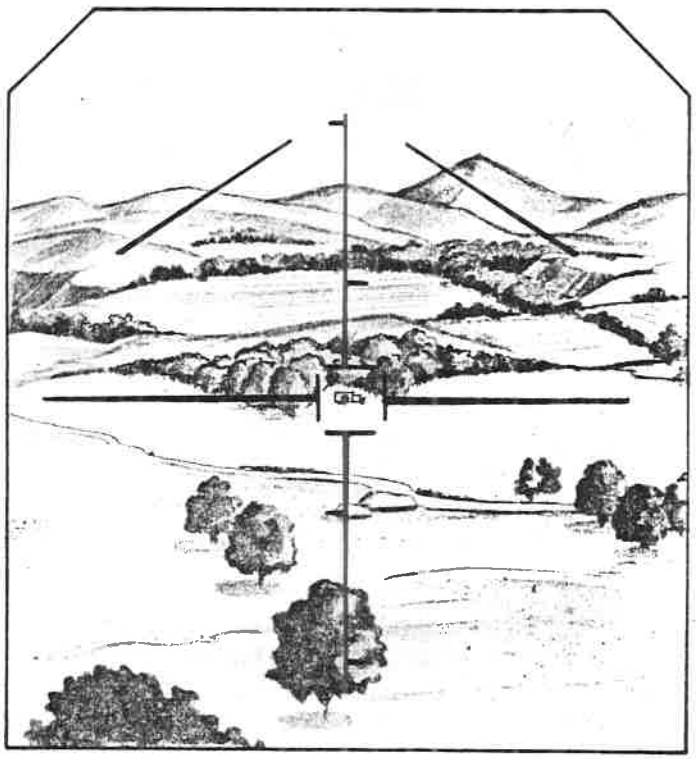
DISTANCE	AIRSPEED 0 KTS			30 KTS			60 KTS			90 KTS			120 KTS		
	QE 103	126	150	QE 103	126	150	QE 103	126	150	QE 103	126	150	QE 103	126	140
1,000	-84	-106	-120	0	-28	-25	-5	-20	-33	-35	-32	-50	-64	-68	-78
1,500	-73	-95	-109	13	-15	-17	7	-10	-17	-20	-23	-35	-52	-60	-67
2,000	-60	-83	-97	28	0	-5	25	4	-5	-3	-10	-18	-37	-46	-52
2,500	-43	-66	-80	45	17	10	42	22	12	13	5	-2	-19	-28	-34
3,000	-22	-44	-58	65	40	32	62	45	28	32	22	15	2	-7	12
3,500	+4	-19	-33	90	68	57	86	70	55	54	48	37	26	17	11
4,000	+34	+12	-2	125	95	87	113	95	80	80	73	57	52	42	37
4,500	+71	+49	+35	150	125	117	140	122	110	105	97	87	79	70	64
5,000	+116	+94	+80	180	150	150	168	148	145	132	123	127	109	100	93
5,500	+172	+149	+135	207	177	180	195	173	182	160	148	170	141	132	123

2.75-INCH FFAR SIGHT CARD

To determine the ballistic correction, the following procedure is used. Select a target which is approximately half the effective range of the weapon from the firing point or the range at which the greatest number of targets will be engaged. When firing the 2.75-inch FFAR armed with a 10-pound high explosive warhead, 2,500 meters is normally used. After determining the engagement range, the appropriate mil setting identified on the sight card for the appropriate quadrant elevation (QE) airspeed and range is placed on the gunsight by rotating the elevation/depression knob the required number of mils. For example, the pilot knows the rocket launchers are set at a QE of 126 mils. The range to the target is 2,500 meters and the engagement airspeed is 90 knots. Using this information, the pilot refers to the sight card and reads a +5.

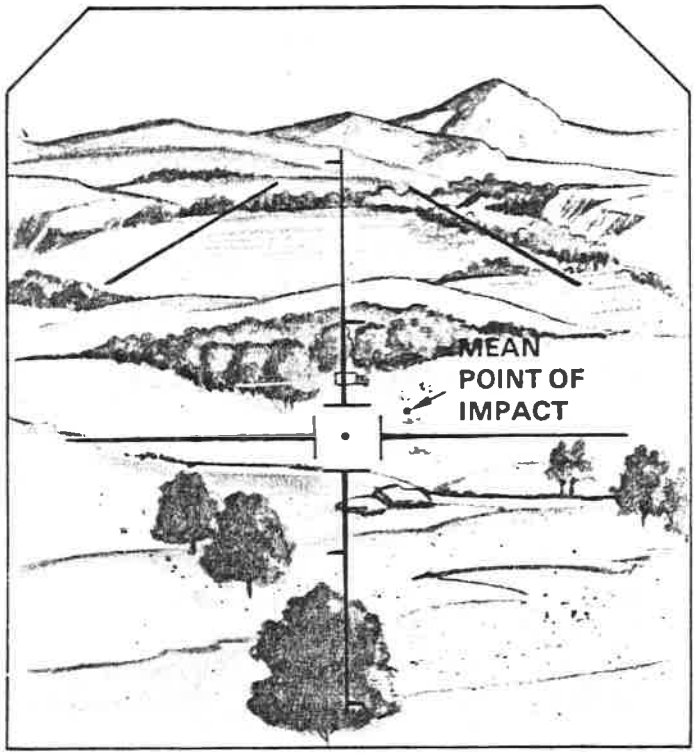


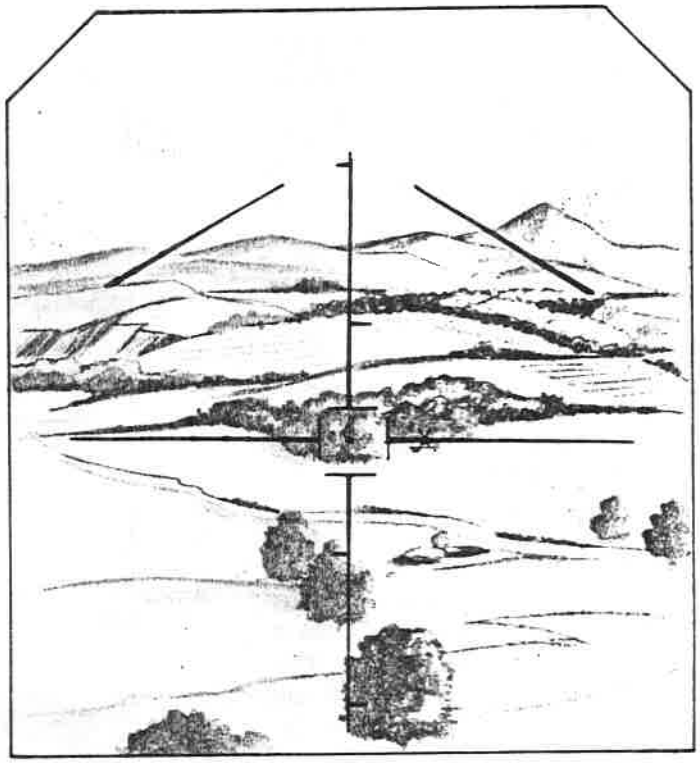




With the proper power setting for the desired airspeed and altitude, aft cyclic is applied just prior to the helicopter's reaching the firing point. The pitch attitude is increased until the pipper is superimposed on the target. When the desired sight picture is achieved, two pair of rockets are fired.

After firing the rockets, the nose of the helicopter is lowered while maintaining alignment of the vertical crosshair of the gunsight reticle on the target. The pilot notes the mean point of impact. He then estimates the distance the burst is either short or beyond the target and converts range error to a mil correction by applying the rule that a 5-mil change in elevation will move the impact point of the rocket 100 meters. If for example, the projectile impacts 200 meters short of the target, 10 mils must be added to the original gunsight setting to cause the projectile to be range correct. This should be confirmed by firing. By comparing the mil setting which resulted in the projectile hitting the target (e.g., +15) with the mil setting which the sight card indicates should hit the target (e.g., +5), the ballistic correction is determined (+10). When engaging future targets, the pilot must refer to the sight card to determine the appropriate mil setting and add the ballistic correction to determine the mil setting that will hit the target.

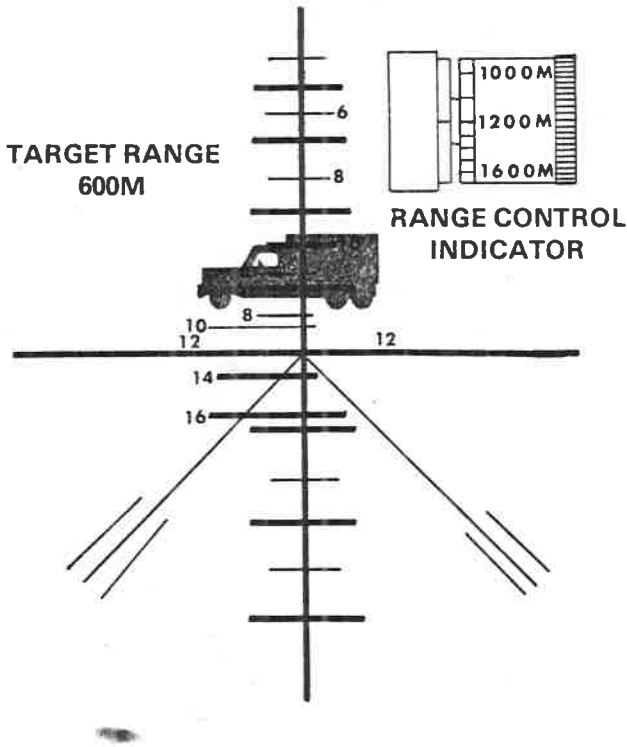




The sight technique for determining and applying lateral correction is the same as discussed for diving fire.

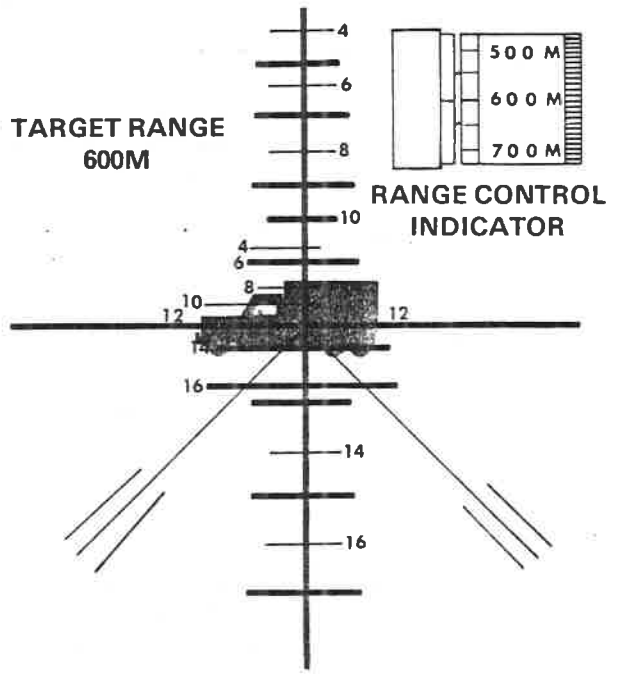
SIGHTING TECHNIQUES

To achieve greatest accuracy, the weapon system should be fired prior to each mission to determine the required corrections to the gunsights. Because this procedure cannot always be accomplished, the combat sight setting should be left on the gunsight or at the last ballistic correction which was computed and the date it was fired should be recorded on the helicopter logbook. This information can be used by an aircrew who has not flown the helicopter to improve the accuracy of the weapon. Also, the quadrant elevation of rocket launchers should be recorded within the logbook. The pilot can use either of the following sighting techniques depending on the type of fire to engage targets.



Flex Weapons

There are two sighting techniques which can be used when firing turret weapons. The first technique is to place the gunsight reticle on the target with the appropriate range line on the target. When using this technique, the range adjust control must be positioned to 1,200 meters. The second procedure is to place the gunsight reticle center dot (intersection of the horizontal and vertical crosshairs) on the target. When using this technique, the estimated range to the target must be placed on the index of the range adjust control. Displacement of the vertical crosshairs left or right of the target to compensate for later error is not required when the compensation (COMP) switch is in the IN position.

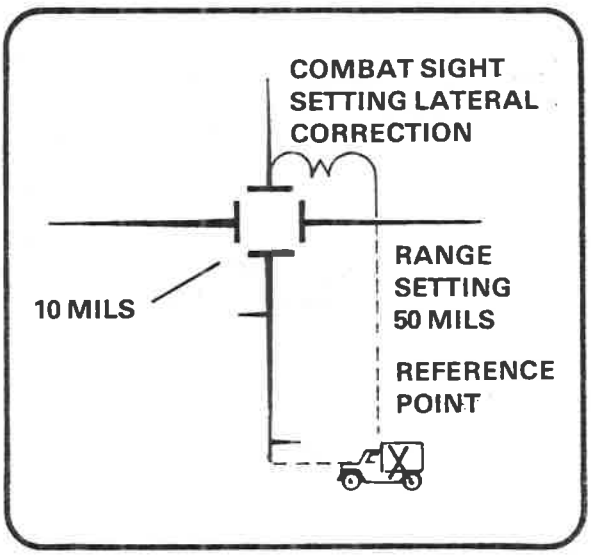


Stowed Weapons

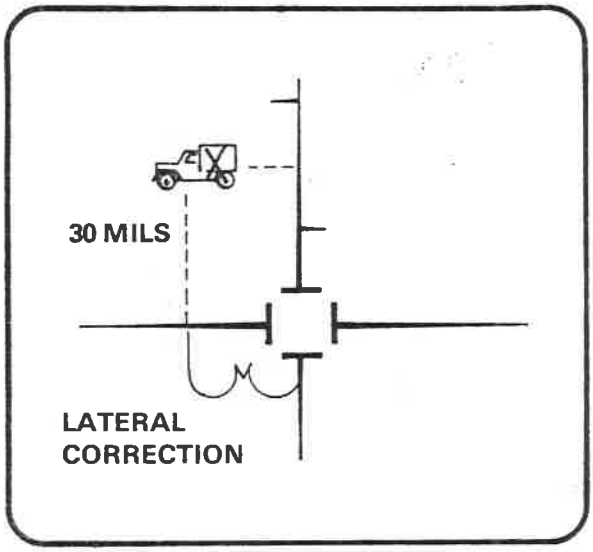
➡ *Diving fire.* There are two sighting techniques which can be used when conducting diving fire. The first is to visually use the vertical mil scale on the gunsight reticle to adjust for range. The advantage of this procedure is that it does not require the pilot to make any adjustment to the mil scale after the combat sight setting for range has been set on the mil scale. However, the major disadvantage of this procedure is that when engaging targets at ranges greater or lesser than 1,000 meters from the combat sight setting range, accuracy is degraded. This procedure requires that the rule of thumb for the 2.75-inch FFAR (5-mil change in elevation will increase or decrease the range of the rocket 100 meters) be used. The combat sight setting lateral correction will normally be too little or too much when engaging a target at a range greater or lesser than the range the combat sight setting was established.

Example: A target is to be engaged at 2,500 meters. The combat sight setting was determined at 1,500 meters. To hit the target at 2,500 meters, 50 mils [5 x 10] elevation must be added to the gunsight. The pilot either mentally notes a position or marks a reference point on the sight reticle 50 mils below the pipper. See page 43 for the mil divisions of the M73 gunsight. The lateral displacement of the reference point from the pipper should be slightly greater than what was determined for the combat sight setting range. When the helicopter is established in a dive with the reference point positioned on the target, the pilot fires the weapon.

Note. To obtain the correct sight picture on the M73 gunsight, the reference point is positioned below the horizontal hairline of the gunsight when the engagement range is greater than the combat sight setting range. If the engagement range is less, the reference point is positioned above the horizontal hairline of the gunsight.



RANGE 100M GREATER THAN THE COMBAT SIGHT SETTING RANGE

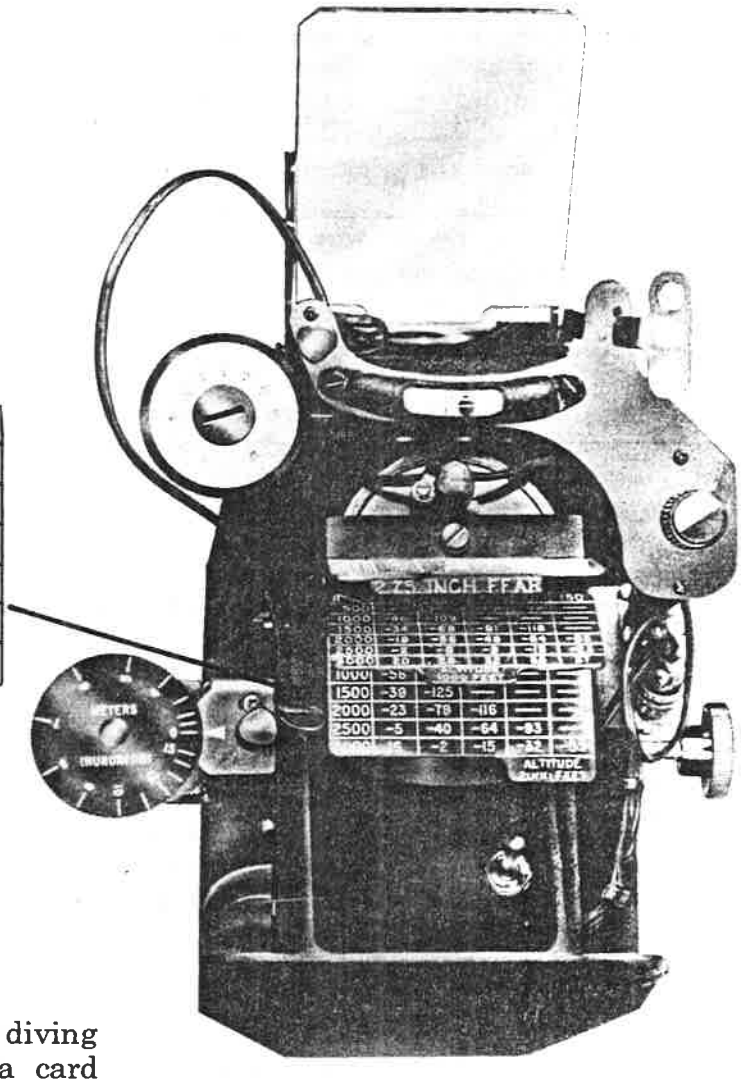


RANGE 600M LESS THAN THE COMBAT SIGHT SETTING RANGE

BALLISTIC DATA CARD

R/S	0	60	90	120	150
500	—	—	—	—	—
1000	−46	−109	—	—	—
1500	−34	− 68	−91	−118	—
2000	− 19	− 36	−48	−34	−85
2500	− 2	− 5	− 9	−15	−23
3000	20	28	32	35	37

ALTITUDE
1000 FEET



A second sighting technique for diving fire is to use the ballistic data card attached to the M73 gunsight. The ballistics data card allows the pilot to accurately engage a target at varying ranges, altitudes, and airspeeds without establishing a combat sight setting. It requires that the pilot place the mil setting identified on the ballistic data card on the mil scale.

Note. The mil setting on the ballistic data card is based on a launcher quadrant elevation of 103 mils.

Example: A target is to be engaged at a range of 2,500 meters. The attack will be initiated at an altitude of 1,000 feet AGL with an airspeed of 150 knots. Using this information, the pilot determines from the ballistic data card that the mil scale must be rotated -23 mils. To hit the target, the pilot must rotate the mil scale to read -23 mils. The correct sight picture using this technique is to place the pipper on the target. Lateral correction cannot be corrected for on the initial firing.

➡ *Terrain flight firing.* The first of two terrain flight firing sight procedures requires that the ballistic correction be applied to the mil setting determined from the sight card. This procedure requires that the pilot mentally add or subtract the ballistic correction to the mil setting for a specific range and place the resulting value on the mil scale.

Example: A target is to be engaged at 4,000 meters. The mil setting for this range when flying 60 knots with a launcher QE setting of 126 mils is 95 mils. The ballistic correction was previously determined to be +10 mils. To hit a target at 4,000 meters, the pilot must mentally add 10 mils to the mil setting on the sight card and place the mil scale on 105 [95 + 10] mils. When the helicopter is over the firing point, the pilot raises the nose until the horizontal hairline is superimposed on the target. The vertical hairline will be positioned laterally from the target the amount and direction determined during the initial adjustment.

Another sighting procedure for terrain flight firing is to apply the ballistic correction automatically by calibrating the mil scale. This is accomplished by releasing the slotted screw on the elevation/depression knob and rotating the scale the amount of the ballistic correction. The reticle image on the gunsight will not be displaced when the mil scale is rotated. After the scale has been slipped and the ballistic correction applied, the mil setting for each range identified on the sight cards can be fired without applying any additional correction for elevation. This procedure eliminates the requirement for the pilot to mentally apply the correction to the mil setting each time the weapon is fired. When the helicopter is configured with two weapons systems that use the M73 gunsight (e.g., 20mm, 2.75-inch FFAR), the mil scale should not be slipped since the ballistic corrections for both systems will seldom be the same. The procedures for applying lateral correction are the same as previously discussed.

Example: A target is to be engaged at 4,000 meters. The required elevation setting for this range when flying 60 knots with a launcher QE setting of 126 mils is 95 mils. The ballistic correction of +10 mils has been previously applied by slipping the mil scale. To hit a target at 4,000 meters, the pilot must place the mil scale on 95 mils. When the helicopter is over the firing point, the pilot raises the nose until the horizontal hairline is superimposed on the target. The vertical hairline will be positioned laterally from the target the amount and direction determined during the initial adjustment.

Note. Anytime the mil scale is slipped to apply the ballistic correction to the gunsight, the number and direction (+or -) it is slipped should be recorded in the helicopter's logbook. When a new ballistic correction must be computed, the pilot refers to this recording and slips the scale in the appropriate direction and magnitude to remove the old ballistic correction.

SUMMARY

To place immediate effective fire on a target, aircrews must use proper sighting techniques. This requires that they have a complete understanding of the adjustments that must be made to the weapons and special corrections that are applied to each gunsight in order to hit the target. The first requirement is to insure that the weapons systems are accurately boresighted. There are two methods (distant aiming point and parallel line) used for boresighting. The most accurate is the parallel line method. After the weapons are boresighted, they must be fired to determine what additional adjustments must be made to cause the projectile to impact where the gunsight is aimed. The procedure to be used is determined by the type of weapon being fired and the mode of delivery.

Harmonization is the process of adjusting the guns to hit where the turret gunsight is aimed when firing in the flex mode. Combat sight setting is a sight setting which has been fired by the pilot and results in the projectile impacting on the target. It is used when conducting diving fire. Ballistic correction applies to terrain flight firing. It compensates for trajectory error in range and is applied to the mil setting on the sight card. After determining the corrected sight setting for the different mode of delivery, the pilot can use this information to engage targets at various ranges and airspeeds. He must, however, be aware of the special considerations (e.g., uncoordinated flight, turning error, attitude error) and apply the necessary sighting techniques required to compensate for a nonstandard condition.

Even though an aircrew is proficient in the proper sighting techniques, its ability to obtain a first-round hit will be significantly reduced unless the range to the target can be accurately estimated. The methods of determining range are estimation by eye, sight mil values, tracer burnout, and map and photomaps.

Additionally, the aircrew must understand and employ a method of identifying the direction to a target. The methods most commonly used are the degree, cardinal heading, and clock. Each of the techniques and procedures discussed are essential skills an attack helicopter aircrew must become proficient in to effectively perform its mission on the battlefield. The sighting technique of "hosing down" the target with a large volume of fire increases the vulnerability of the helicopter and reduces staying power, thus reducing the effectiveness of the attack helicopter.

CHAPTER FOUR

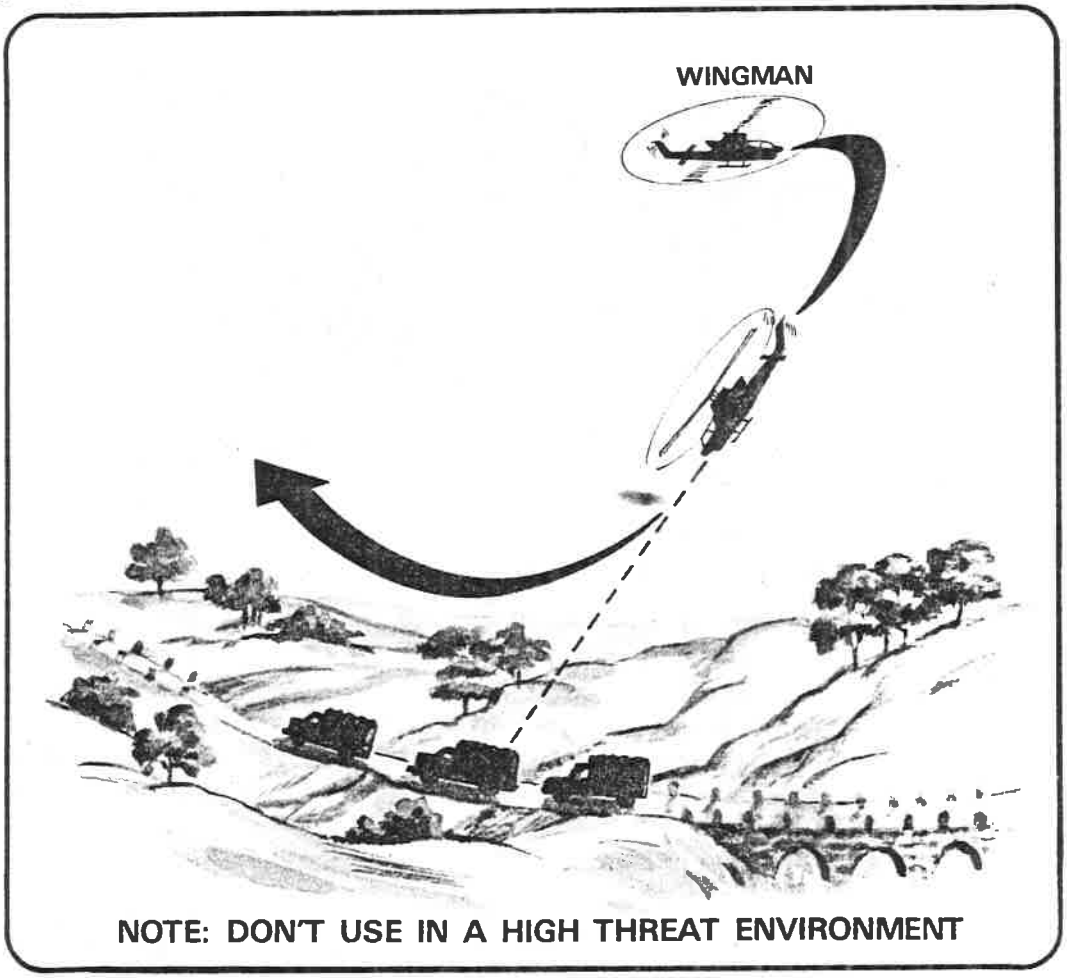
TERRAIN FLIGHT FIRING TECHNIQUES

INTRODUCTION

In the past, the attack helicopter has been employed to engage targets at relatively close ranges (3,000 meters or less) using diving fire techniques. Because the threat restricts this type of delivery, new terrain flight firing techniques have been developed. This new capability will allow the aircrews of the attack helicopter to deliver effective fire on area targets while minimizing their vulnerability. This chapter addresses terrain flight delivery techniques for the 2.75-inch FFAR. It also discusses specific capabilities and limitations for the 20mm cannon and the flex weapons systems for employment at terrain flight altitudes.

PREFLIGHT CONSIDERATIONS

To insure the reliability and accuracy of the weapons systems, daily maintenance, frequent boresighting, close coordination between aircrews and armament personnel, and proper care of gunsights are required. Inspection of the gunsight should be performed as part of the preflight. Gunsight deficiencies should be corrected before performing the mission. When armed with stowed weapons, the aircrew must know the quadrant elevation of the rocket launchers or gun pods. Also, the pilot should check the aircraft logbook to determine the ballistic correction.

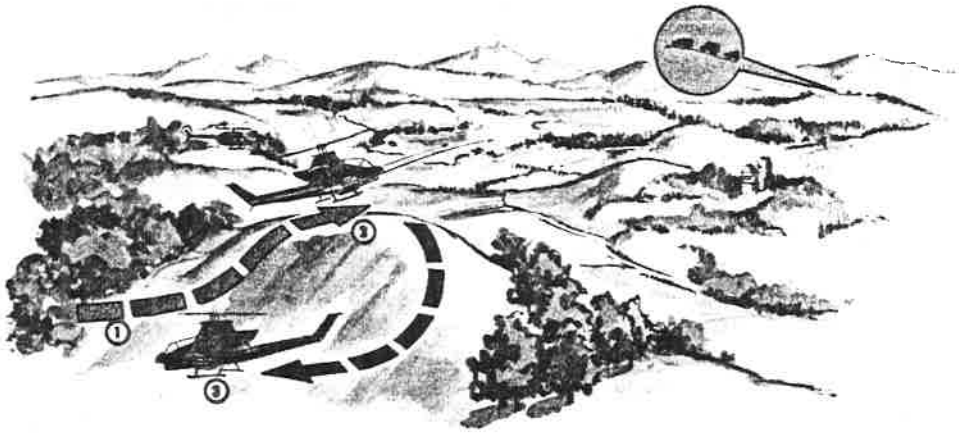


TYPES OF FIRE

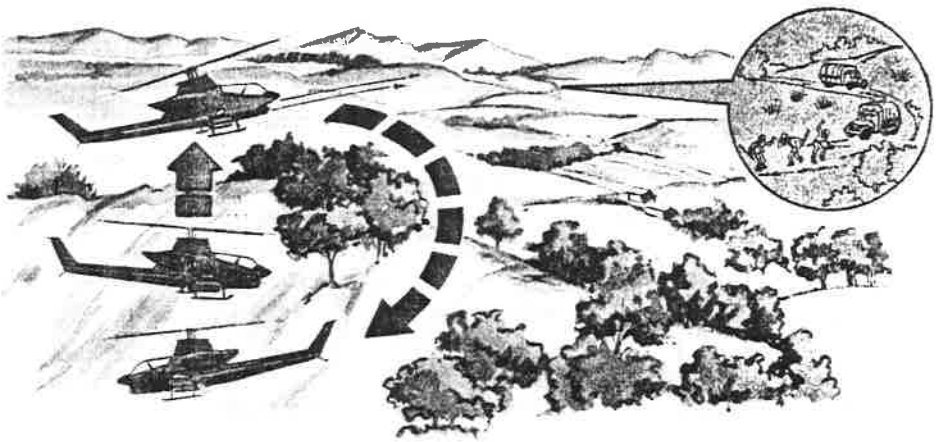
The attack helicopter aircrew can engage targets using any of the three types of fire.

Diving fire is the most accurate of the three types of fire. It is normally initiated above 1,000 feet AGL. During the attack, a constant angle is maintained while the airspeed increases. Diving fire normally cannot be performed when employing the attack helicopter in a high threat environment because the helicopter is more vulnerable to the enemy air defense weapon when operating above terrain flight altitudes.

Running fire is fire delivered when the helicopter is in effective translational lift, normally above 20 knots. Both direct and indirect fires can be delivered during running fire. The forward airspeed adds stability to the helicopter, thus increasing the delivery accuracy of the weapons system. This type of fire can be performed at terrain flight altitudes and is less vulnerable to enemy air defenses than diving fire.



Hovering fire is fire delivered when the helicopter is below effective translational lift. It may be stationary or moving, but movement is always below effective translational lift airspeed. Because the trajectory of the projectile is not significantly changed, this TC does not differentiate between the two conditions of hover flight. It is normally performed after unmasking from an ambush position; however, indirect hover fire may be delivered from firing positions obscured from the enemy by terrain features. The hover firing position is maintained for only short periods of time. Following missile track or short burst of automatic weapons fire, the helicopter remasks. Where terrain permits, the helicopter should be moved laterally between bursts of fire so that it does not appear to the enemy twice from the same position. Because the helicopter is less stable at a hover, the accuracy of the weapons systems is reduced. Point type weapons are the most effective weapons when firing from a hover.



MODES OF FIRE

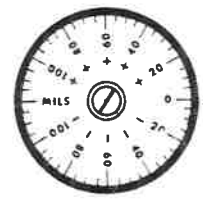
The attack helicopter can hit a target using either direct or indirect fire. *Direct fire* is used to engage targets which are visible to the aircrew. *Indirect fire* is the engagement of a target that is not visible to the crew and is used primarily against area targets. Both types of fire (running and hover) can be used to conduct direct and indirect fire. Direct fire can be used when firing any weapon subsystem, but indirect fire is normally accomplished using the 2.75-inch FFAR.

DIRECT FIRE

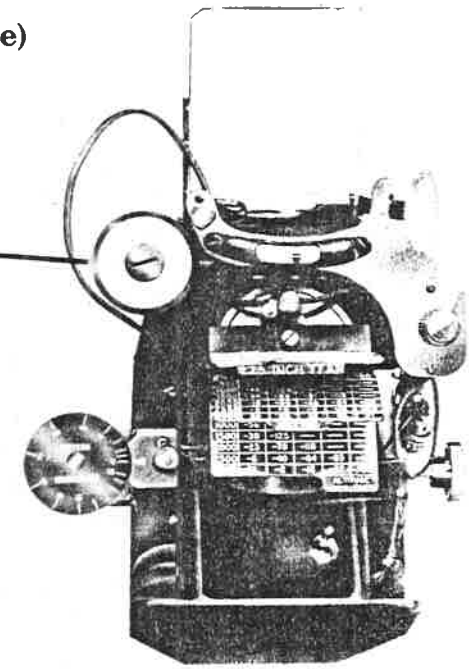
The techniques used to conduct direct fires vary, based on the weapon subsystem being fired and the type of fire. Presented below are examples of direct fire delivery techniques used in each type of fire while firing the 2.75-inch FFAR. Direct firing techniques for other weapons subsystems are discussed later in this chapter.

Direct Fire Delivery Techniques (Running Fire)

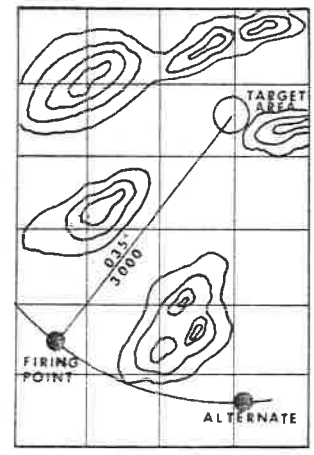
When performing *direct running fire,* a firing point on the ground must be selected from which the weapons systems will be fired. The location of the firing point must provide unobstructed visibility with the target. The distance to the target should be approximately the same as one of the ranges in the sight cards later in this chapter. A procedure used to determine a firing point is to draw one or more arcs at varying ranges using the target as the apex of the arc. Tentative selection of primary and alternate firing points is made by map reconnaissance and final selection is made during the mission. This procedure can be used for determining firing points for both direct and indirect fire delivery techniques.



MIL SCALE

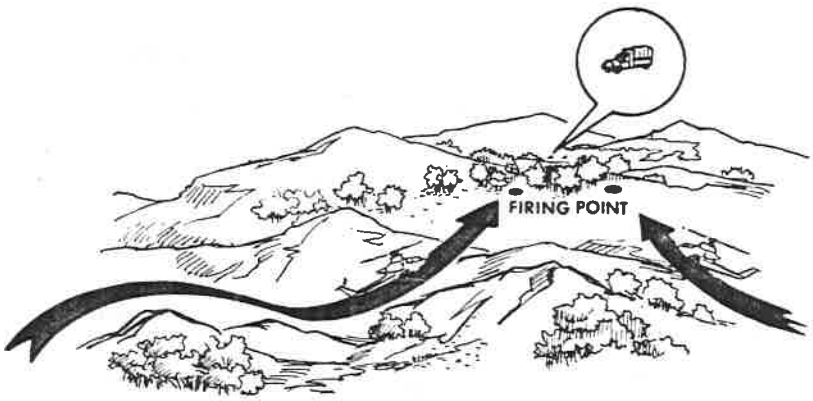


M73 REFLEX SIGHT

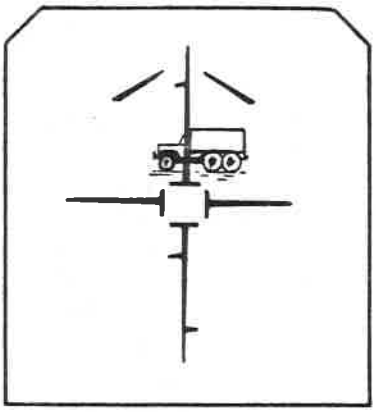


Determine the mil setting corresponding to the desired range on the sight card and apply the ballistic correction. The resulting value is placed on the mil scale of the gunsight.

Establish a flightpath which will cause the helicopter to overfly the firing point while maintaining the desired direction of fire.



The helicopter is aligned with the target when the vertical hairline on the gunsight reticle is centered on the target.

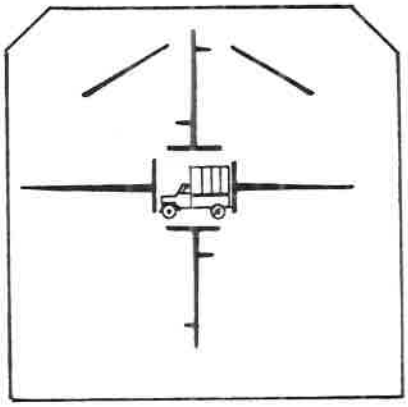


SIGHT PICTURE FOR CORRECT ALIGNMENT ON THE TARGET

Just prior to reaching the firing point, the pilot must apply aft cyclic to raise the nose of the helicopter to position the horizontal hairline on the target. Movement of the cyclic should be a continuous application of aft pressure. Abrupt movement of the cyclic reduces the accuracy of the weapons system and will cause an increase in the height of climb during the maneuver. To achieve greater accuracy, a stabilized power setting should be established and maintained throughout the maneuver. Even though the helicopter will climb, slower airspeeds and smoother application of control movements will reduce the amount of climb.

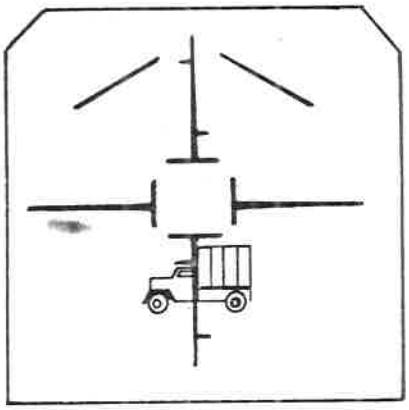
PITCH UP TO ACHIEVE THE PROPER SIGHT PICTURE TO FIRE

When the intersection of the horizontal and vertical hairline (pipper) appears on the target, the weapon system is fired.



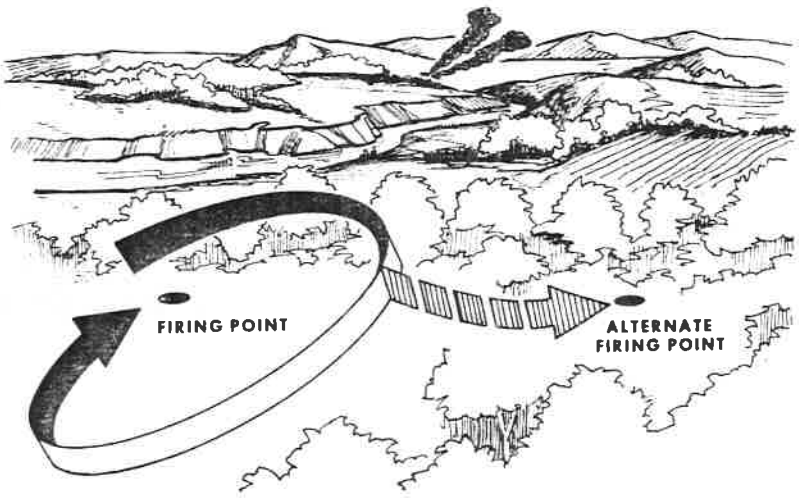
CORRECT SIGHT PICTURE TO FIRE

The length of time the gunsight can be held on the target is limited to a very short period of time. Firing should be stopped when the sight picture no longer can be maintained. This limitation is applicable for all delivery techniques that require a pitching motion to attain the desired firing attitude.



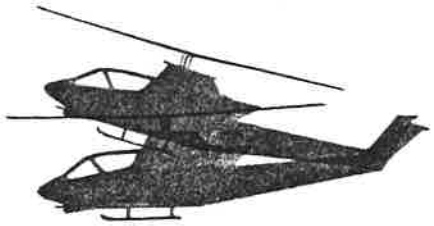
CEASE FIRE

If additional firepower is required on the target after firing the initial volley, or adjustment is required to hit the target, the pilot should return to the firing point and repeat the running fire procedure. Alternate firing points should be selected to avoid repeated overflights of the same firing point.



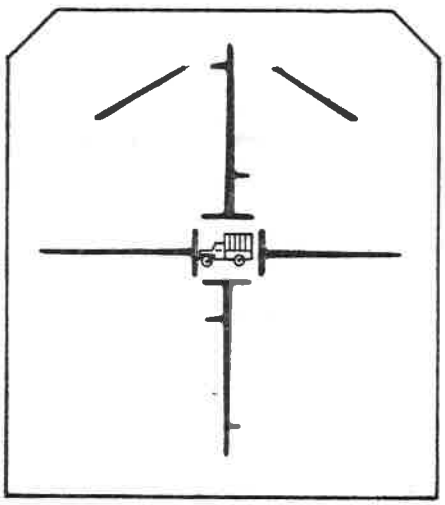
Direct Fire Delivery Techniques (Hover Fire)

When performing *direct hover fire,* a firing point is selected which is approximately the same distance to the target as one of the ranges on the sight card. Place the mil setting corresponding to the desired range on the mil scale. When engaging the target, cyclic is applied to adjust the nose of the helicopter until the pipper is on the target; simultaneously, collective pitch is applied as necessary to keep the tail rotor from hitting terrain obstacles.



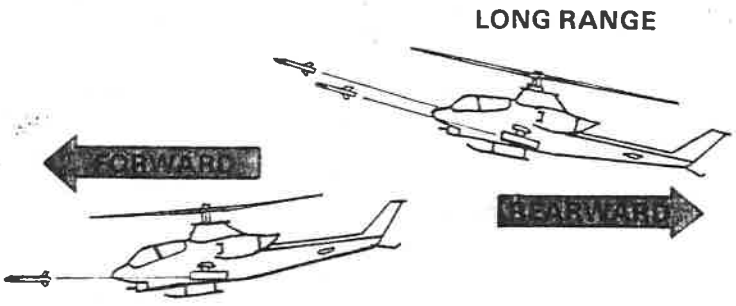
WHEN RAISING THE NOSE TO FIRE, PIVOT THE AIRCRAFT ON ITS TAIL

Once the proper sight picture is achieved, the weapon is fired.



CORRECT SIGHT PICTURE TO FIRE

When engaging targets at short ranges, forward movement may occur due to the nose-low attitude required to hit the target. Conversely, when engaging targets at the maximum range of the weapons system, rearward flight may result. Caution must be taken to insure obstacle clearance behind the helicopter before firing.



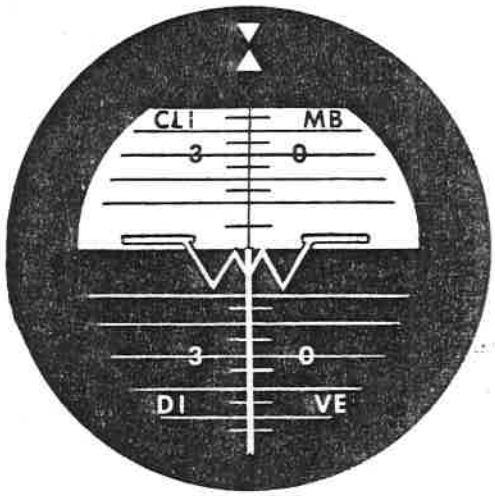
SHORT RANGE

INDIRECT FIRE

Indirect fire is used primarily against area targets. The delivery technique used to conduct indirect fire differs primarily in the means used to determine the correct pitch attitude for the different ranges and the method of aiming the weapons. Since indirect delivery techniques have not been developed for flex weapons, only stowed weapons will be discussed. To perform indirect fire, using either type of fire, the helicopter attitude indicator is the primary means of determining the required pitch attitude to attain the desired range. Two additional techniques can be used. They are the distant aiming point and the stable fire technique. Specific techniques for conducting indirect fire for each mode of delivery are discussed below using the 2.75-inch FFAR as the armament subsystem being fired.

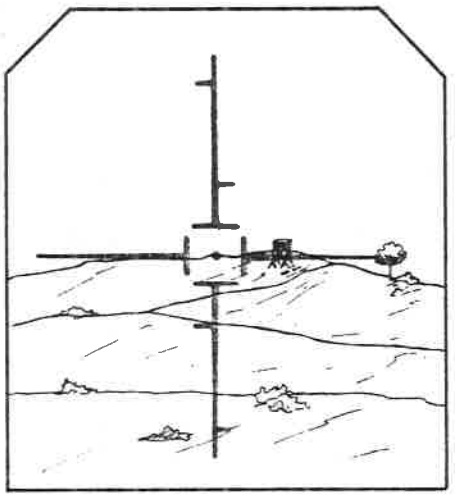
METHODS OF DETERMINING PITCH ATTITUDE

PRIMARY



AIRCRAFT ATTITUDE INDICATOR

ALTERNATE

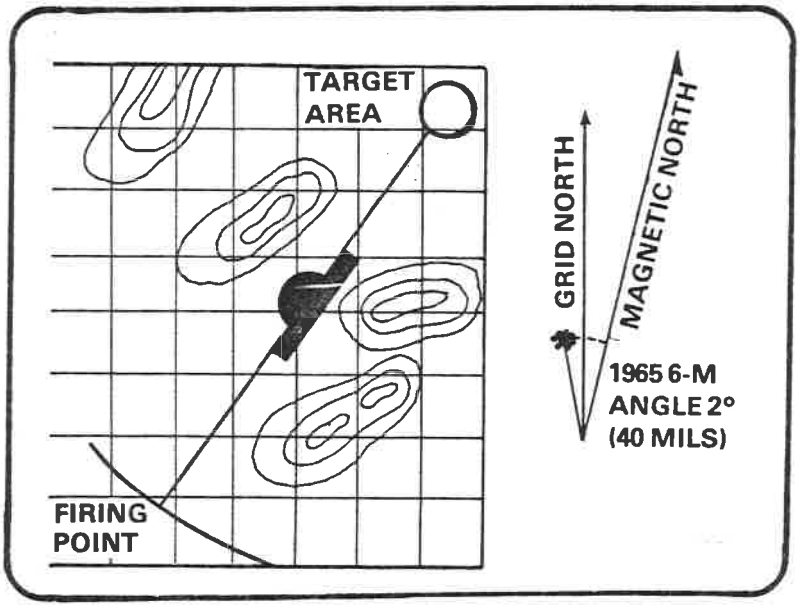


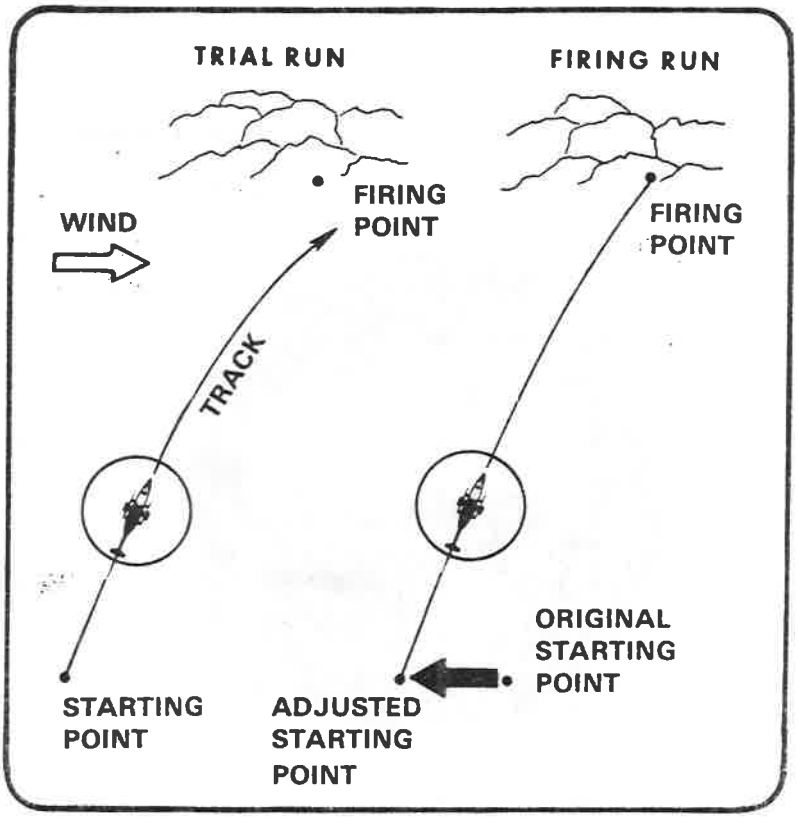
M73 GUNSIGHT AND THE DISTANT AIMING POINT

Indirect Fire Delivery Techniques (Running Fire Using the Attitude Indicator)

When performing *indirect running fire,* a firing point on the ground must be selected over which the weapons system will be fired. The method of selecting a firing point is the same as previously discussed except the target cannot be seen from the firing point. The direction to the target is then measured using a tactical map and converted to a magnetic heading.

To determine the effects of wind drift on the helicopter, a trial run along the preselected approach to the firing point should be conducted. As the helicopter is flown down the flightpath, on the firing heading, the pilot should observe for drift. If the helicopter drifts off course prior to reaching the firing point, he should fly the approach again and adjust the flightpath either left or right of the original flightpath so that the helicopter crosses over the firing point aligned on the firing heading. This procedure compensates for drift without having to fly the helicopter out-of-trim. The flight maneuver required during the firing phase is the same as previously discussed in direct running fire; however, the sighting technique is different.





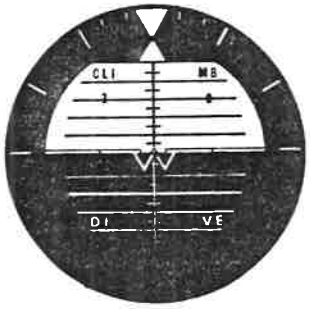
During the firing maneuver, the pilot must maintain the heading by reference to the heading indicator. Constant crosscheck between the attitude and heading indicators is required. The weapons should not be fired until both instruments indicate the desired readings.

When using the attitude indicator to determine pitch attitude, the pilot may use either of two methods. One method is to adjust the horizon bar the desired number of degrees above the miniature aircraft (A); and when over the firing point, raise the nose of the helicopter until the miniature aircraft is level with the horizon bar (B).

A second method is to level the attitude indicator for the specific attack airspeed (normally 60 knots) (C). To fire, raise the nose of the helicopter until the miniature aircraft indicates the desired number of degrees above the horizon bar (D).

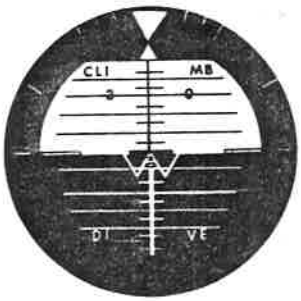
A

ADJUST THE HORIZON BAR ABOVE THE MINIATURE AIRCRAFT



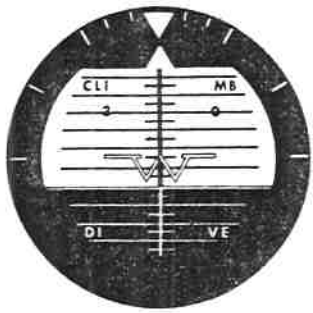
B

RAISE THE NOSE AND FIRE



C

LEVEL THE ATTITUDE INDICATOR WHEN AT THE DESIRED AIRSPEED



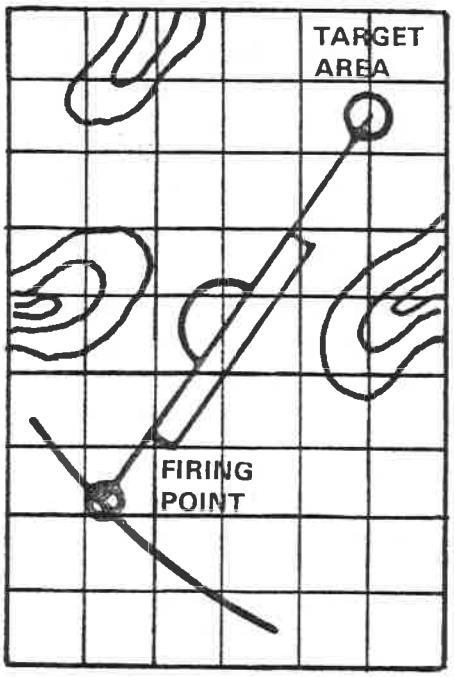
D

RAISE THE NOSE AND FIRE

Note. To achieve the desired range for the specific pitch attitude identified on the sight card, the attitude of the helicopter prior to beginning the pitch-up maneuver should be approximately 5° nose-low. (The attitude of the attack helicopter at 60 knots airspeed with the turret weapons installed and one-half load of 7.62mm and 40mm ammunition.) A higher or lower flight attitude will result in the rocket impacting beyond or short of the target.

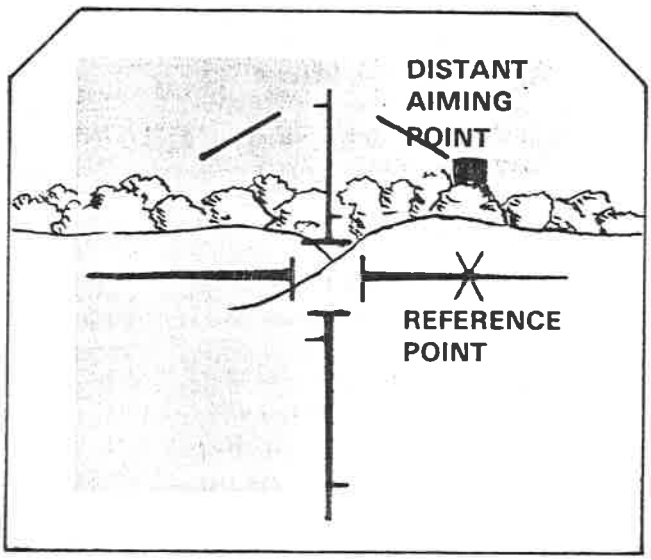
Indirect Fire Delivery Techniques (Running Fire Using the Gunsight)

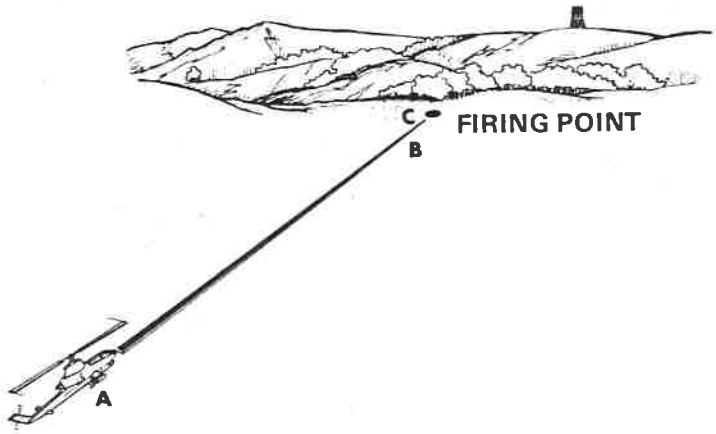
A second sighting technique used for firing indirect running fire is to use the M73 gunsight and a distant aiming point. This method is less accurate than other indirect delivery techniques, but effect on the target can be assured by using an observer to adjust fire on the target. To perform indirect fire, the aircrew must first select a firing point and determine the magnetic heading to the target. (The procedures used are the same as previously discussed.) After determining the range to the target, the required mil setting is placed on the mil scale of the gunsight.



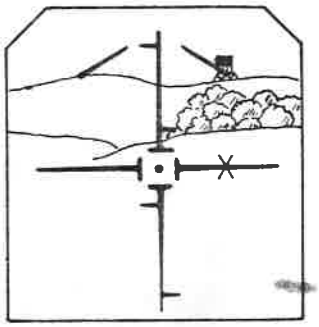
DETERMINE THE MAGNETIC HEADING TO THE TARGET

Before firing the first round, a distant aiming point must be identified which will be used as a reference for establishing the pitch attitude and adjusting for deflection on subsequent firings. The helicopter should be positioned over the firing point and aligned with the target using the heading indicator. Viewing through the M73 gunsight, the pilot selects a distant aiming point located between the firing point and the target. The distant aiming point must be located within the limits of the sight reticle and should be as close to



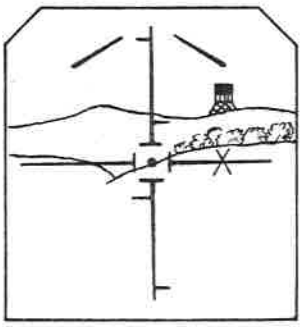


the vertical crosshair as possible. It should be located at an elevation slightly higher than the firing point. A point is then marked on the horizontal crosshair of the sight reticle directly below the distant aiming point or a mental note is made of this position. This mark is referred to as the reference point in future discussions.



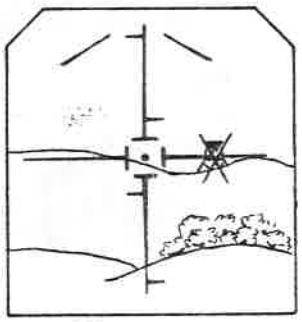
VIEW AS THE HELICOPTER APPROACHES THE FIRING POINT

The pitch-up maneuver is similar to that used in direct fire except that the distant aiming point is used to sight on as opposed to the target. As the helicopter approaches the firing point, the heading indicator is used to maintain alignment with the target.



VIEW WHEN BEGINNING THE PITCH UP MANEUVER

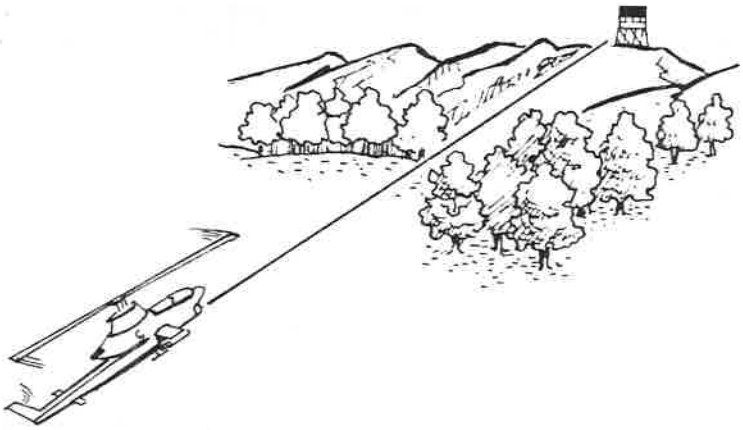
When the distant aiming point comes into view through the gunsight, the pilot transitions from the heading indicator to the gunsight to maintain heading alignment with the target. Heading is maintained by positioning the distant aiming point along an imaginary vertical line projected up from the reference point. During the pitch-up maneuver, the correct sight picture is attained when the distant aiming point is superimposed on the reference point.



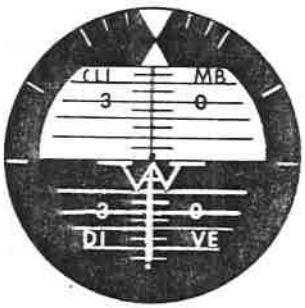
VIEW TO FIRE

Indirect Fire Delivery Techniques (Hover Fire)

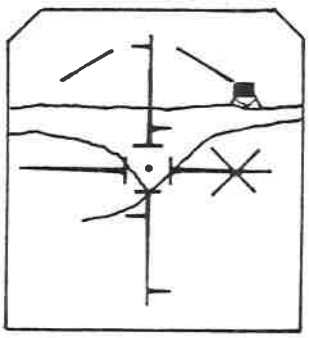
Indirect hover fire is conducted from a selected point on the ground. The aircrew must know the heading to the target and the approximate range. The procedures for selecting a firing point and determining the firing heading are the same as previously discussed. Both sighting techniques (attitude indicator and gunsight) for indirect running fire can be used for indirect hover fire.



When the pre-firing procedures have been completed, the pilot aligns the helicopter with the target at a stabilized hover using heading indicator or the distant aiming point.

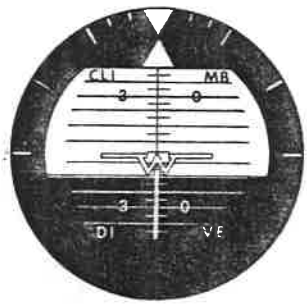


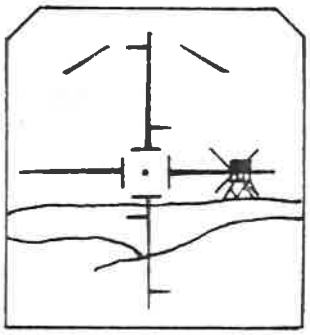
LEVEL THE ATTITUDE INDICATOR



MARK THE REFERENCE POINT

The pitch-up maneuver is initiated by applying aft cylic. Simultaneously, collective pitch is added to keep the tail rotor clear of obstacles. The desired pitch attitude is indicated by the position of the miniature aircraft on the horizon bar or the horizontal crosshair on the gunsight is level with the distant aiming point. The effect of tuck when firing and the rearward movement of the helicopter must be anticipated by the pilot.

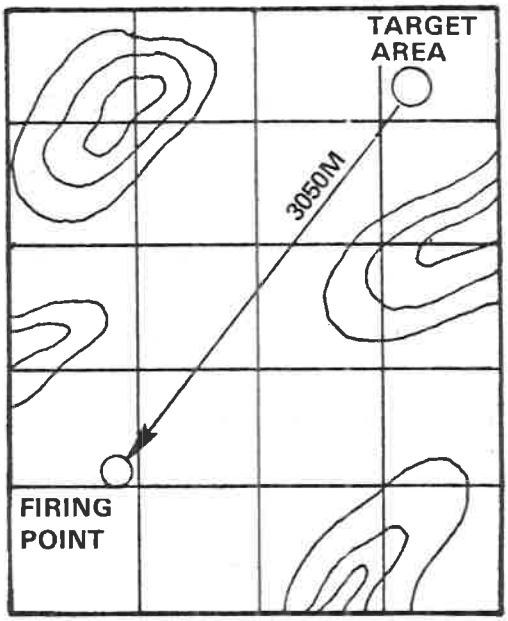




PITCH UP AND FIRE

Indirect Fire Delivery Techniques (Stable Fire)

The stable indirect hover delivery technique does not require an attitude change of the helicopter to fire the weapon. A limitation of this delivery technique is that only one range can be fired. During premission planning, the QE on the launchers should be set for the most desired range (see sight card). To accurately engage a target, a firing point must be selected at a distance from the target equal to the range for the QE set on the launcher. The procedures for determining the firing heading are the same as previously discussed.



When the target is to be engaged, the pilot establishes a stabilized hover over the firing point and aligns the helicopter with the target by referring to the heading indicator. The target is engaged from the hover attitude. This technique has the advantage that large volumes of fire can be placed on the target while maintaining a stabilized firing attitude.

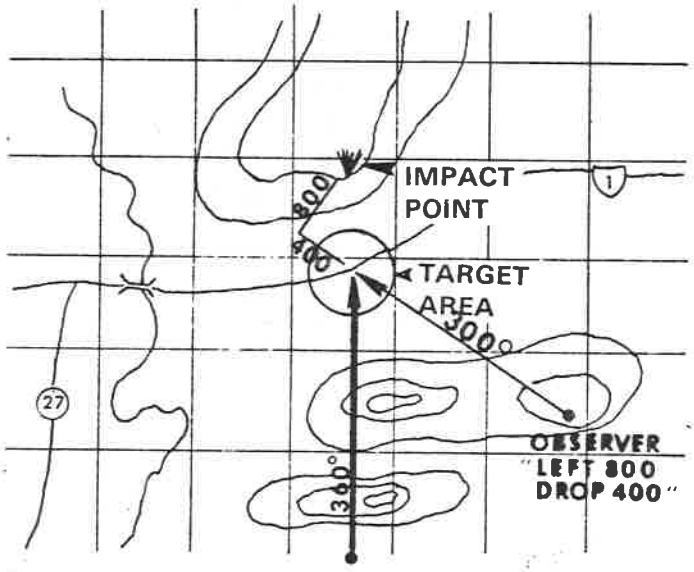
FIRE FROM A HOVER ATTITUDE

FIRE ADJUSTMENT

The adjustment of fire on a target requires that the aircrews observe the impact of the round in relation to the target or an observer reports his corrections to the aircrew. Even though firing direct fire, observer corrections may be necessary to adjust fire on the target because the helicopter must mask to avoid detection. Ideally, the observer will report corrections by using the gun-target line; however, this procedure cannot always be used. The aircrew must be capable of converting observer corrections into air correction based on the position of the helicopter. Using the dead-reckoning computer (CPU-26A/P), the aircrew can quickly and accurately determine the corrections required to hit the target.

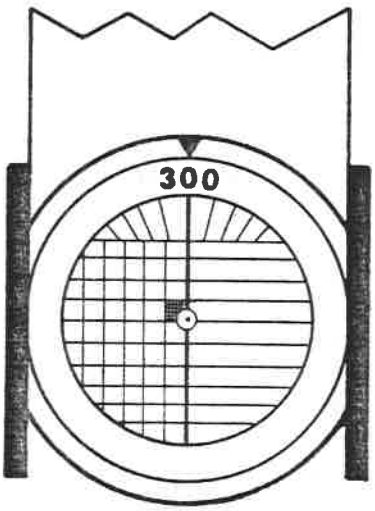
Computation of Firing Data

Assume the observer's direction to the target is 300°. He senses the round to be over right and requests that the impact of the projectile be moved left 800 and drop 400. The heading of the aircraft is 360°.

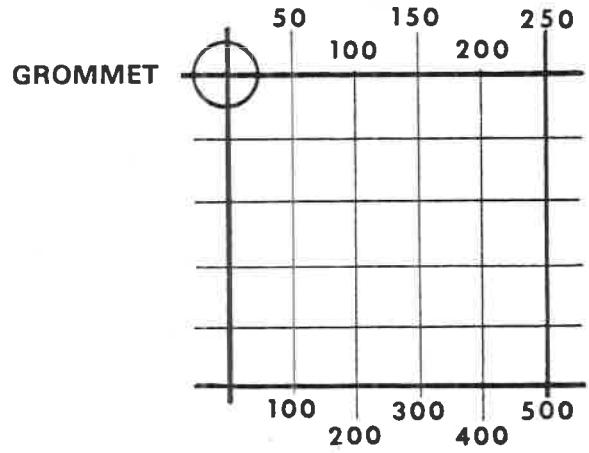


Then move the rectangular sliding grid until the grommet is positioned over the intersection of a major gridline. Normally, the rectangular grid should be centered within the plotting disk.

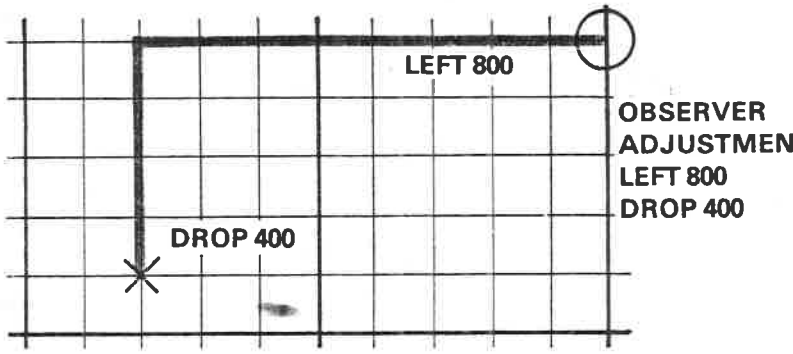
To determine the air correction, first rotate the compass rose until the azimuth of the observer to the target is at the true index (300°).



Assign a value for each grid square. For observer corrections less than 1,500 meters but more than 600 meters, the value of 100 meters for each grid should be used. When making adjustments of less than 600 meters, greater accuracy is achieved by using each grid square to represent 50 meters.

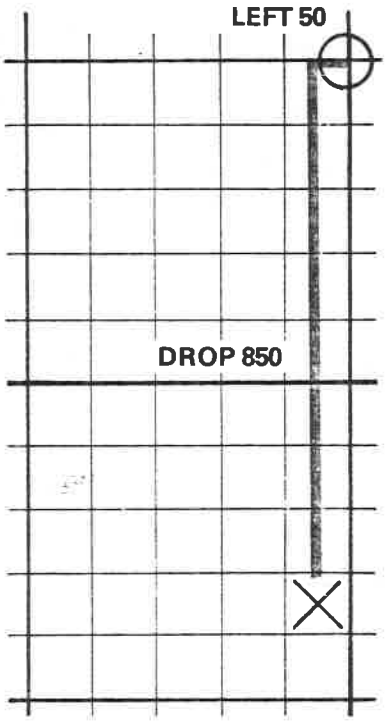


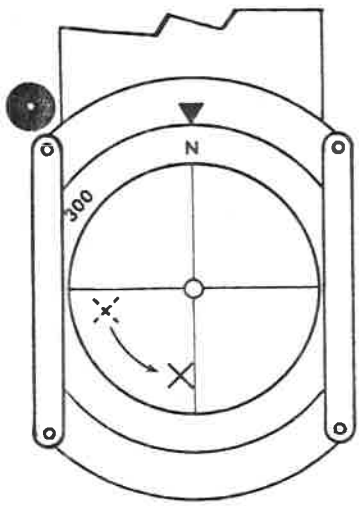
Mark the observer's corrections on the plotting disk. A correction "drop" will be plotted below the grommet while "add" corrections are plotted above the grommet. Lateral corrections are depicted by positioning the pencil marks left or right of the grommet.



Rotate the compass rose until the helicopter heading is at the true index (360°).

Read the firing data from the position of the pencil mark. The number of grids the pencil mark is displaced laterally and vertically from the grommet is the correction required to hit the target from the helicopter position. Using the data in the above situation, the aircrew computes the required correction to be left 50 and drop 850 meters.





AIRCREW CORRECTION
LEFT 50, DROP 850

Direct Fire Adjustment Procedures

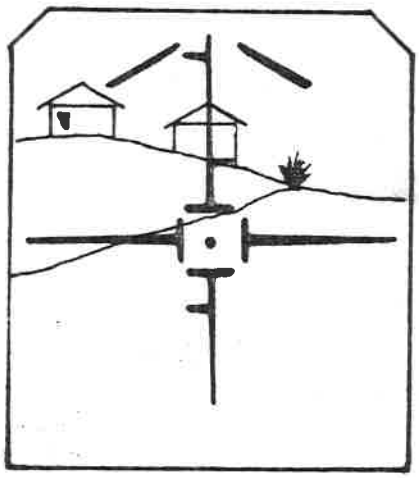
To adjust direct fire, the aircrew observes the impact of the rocket and senses corrections required to hit the target. For example, the gunner senses a requirement to correct left 100 and add 500 meters. The range to the target is approximately 3,500 meters. Using the rule of thumb for the 2.75-inch FFAR that a 5-mil change in elevation moves the impact point of the rocket 100 meters, plus 25 mils is required to increase the range 500 meters. This correction is applied to the mil scale on the gunsight.

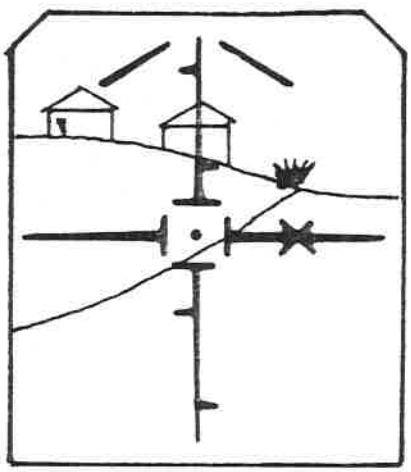
Two methods can be used to determine the deflection correction.

The first procedure requires that the pilot observe the lateral displacement of the rocket from the vertical centerline through the gunsight. He can mark a reference point on the horizontal hairline of the sight reticle or mentally note the point of impact. This point is the aiming reference to correct for deflection when firing subsequent engagements.

The second method requires the aircrew to compute the deflection error in mils. To determine the required correction, the rule that 1 mil will move the strike of the rocket 1 meter laterally at 1,000 meters is used. If a left 100 meters is required and the target is located at a range of 3,500

"LEFT 100, ADD 500"



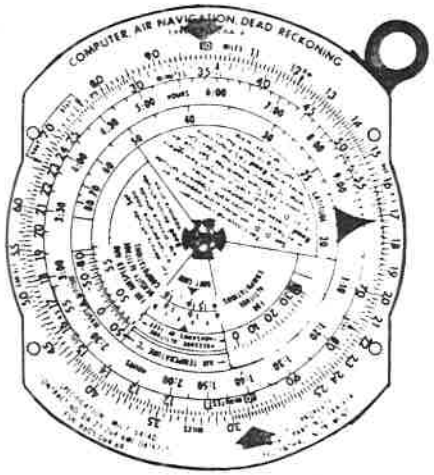


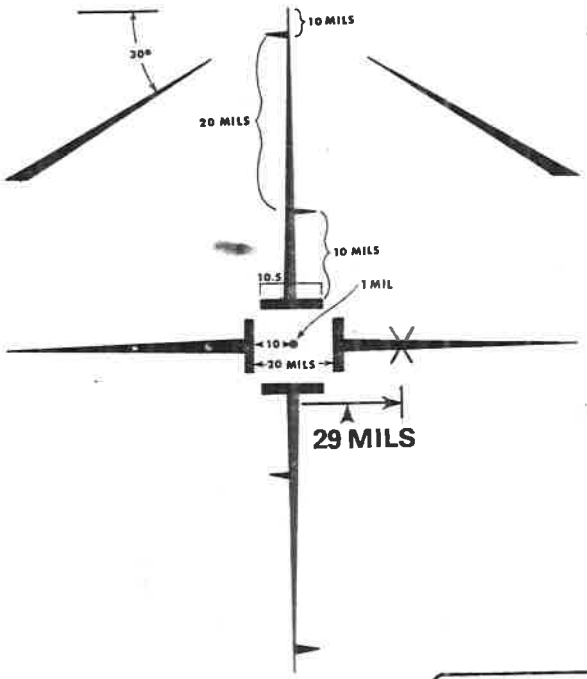
meters, a correction of 29 mils is required to hit the target. This correction can easily be computed using the dead reckoning computer (CPU-26A/P).

Rotate the inner scale of the slide rule until the range to the target, expressed in thousands, is beneath the 10 on the outer scale.

Read the mil correction on the outer scale above the figure representing the desired shift (expressed in tens) on the inner scale.

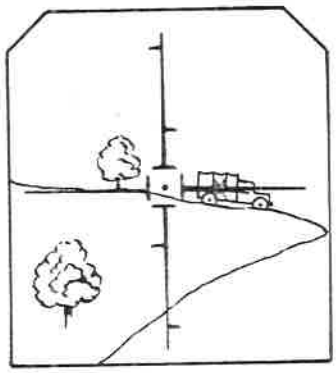
Example. The required distance the projectile must be moved laterally is 100 meters and the range to the target is 3,500 meters. Rotate the inner scale until 3.5 is beneath the 10 on the outer scale. Read the mil shift above the 10 on the outer scale. The answer is 28.8 or 29 mils.





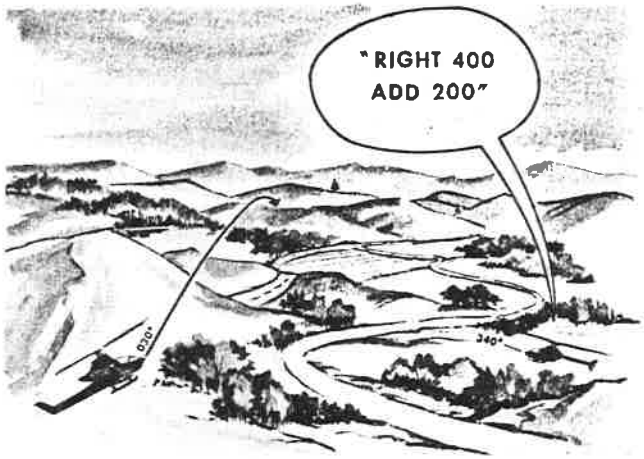
After the lateral correction is determined, the pilot marks a reference point along the horizontal crosshair of the sight reticle or mentally notes this reference point 29 mils to the right of the pipper. Lateral corrections are always applied in the opposite direction to the required heading change so that the nose of the helicopter will move toward the target.

When the reference point is placed on the target, the correct elevation and deflection to hit the target has been applied. The next lateral adjustment is made from the reference points as just discussed.



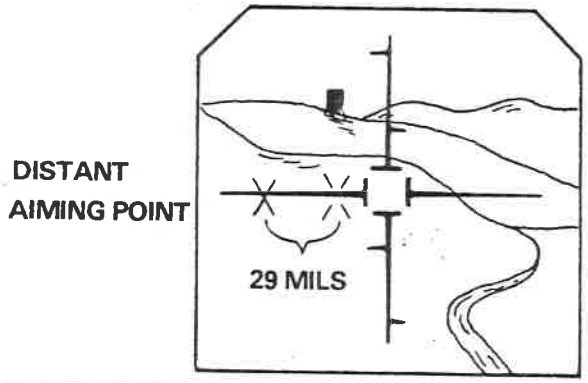
Indirect Fire Adjustment Procedures [Distant Aiming Point)

Corrections to adjust for indirect fire must be received from an observer. After receiving the observer's corrections, the aircrew must convert these corrections into aircrew corrections using the dead reckoning computers as previously discussed. After computing the aircrew correction, the elevation and deflection required to hit the target must be determined. For example, the aircrew correction is computed to be right 100, add 400. The range to the target is approximately 3,500 meters. Using the rule of thumb for range adjustment previously discussed, 20 mils is required to increase the range 400 meters.

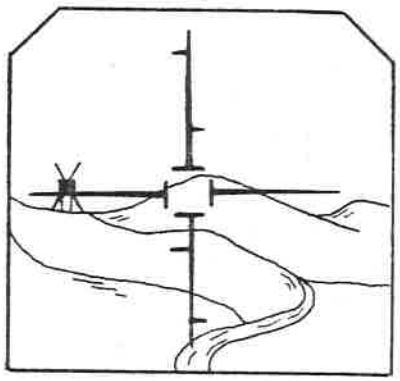


A 1° CHANGE OF HEADING RESULTS IN A LEFT OR RIGHT SHIFT OF 20 METERS FOR EACH 1,000 METERS OF RANGE

This correction is applied to the mils scale on the gunsight. To compute the deflection correction, the aircrew must compute the mil correction using the slide rule of the dead reckoning computer as previously discussed. Using this procedure, the lateral correction is computed to be 29 mils. This correction is marked or mentally noted on the horizontal crosshair of the sight reticle 29 mils left of the previous mark.



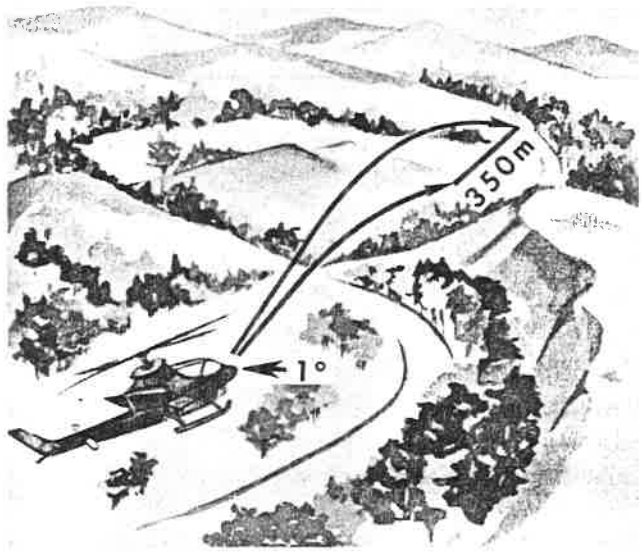
When the new reference mark is superimposed on the distant aiming point, the elevation and deflection corrections required to hit the target have been applied. Subsequent lateral adjustments are made from the new reference mark.



VIEW TO FIRE

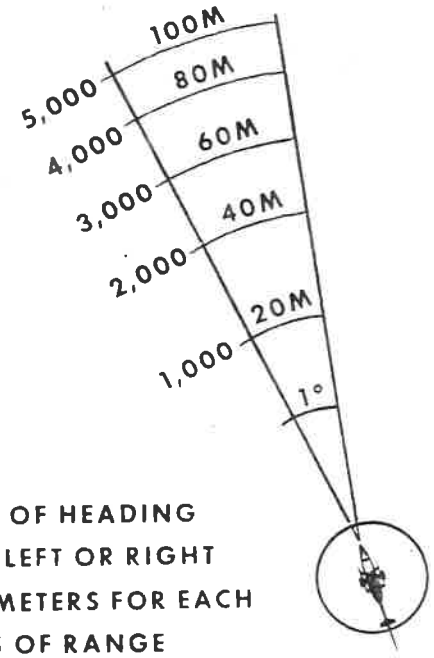
Indirect Fire Adjustment Procedures (Attitude Indicator)

After receiving the observer's corrections, the aircrew correction is determined to be right 100, add 800. The range to the target is 3,500 meters. The unit of measurement for range adjustment is degrees; therefore, the rule of thumb that applies 1° will increase or decrease the range of the rocket 350 meters. Using this rule, the pilot must increase the pitch attitude 2° (approximately one-bar width on the attitude indicator). Because the scale on the attitude indicator cannot be read accurately, adjustments of less than 1° (350 meters) cannot be made. Another method to adjust for range is to move the helicopter either a lesser or greater distance from the initial firing point the amount required to correct for the range error and fire using the same range pitch attitude.



± 1° CHANGE IN PITCH ATTITUDE = ± 350 METER RANGE SHIFT

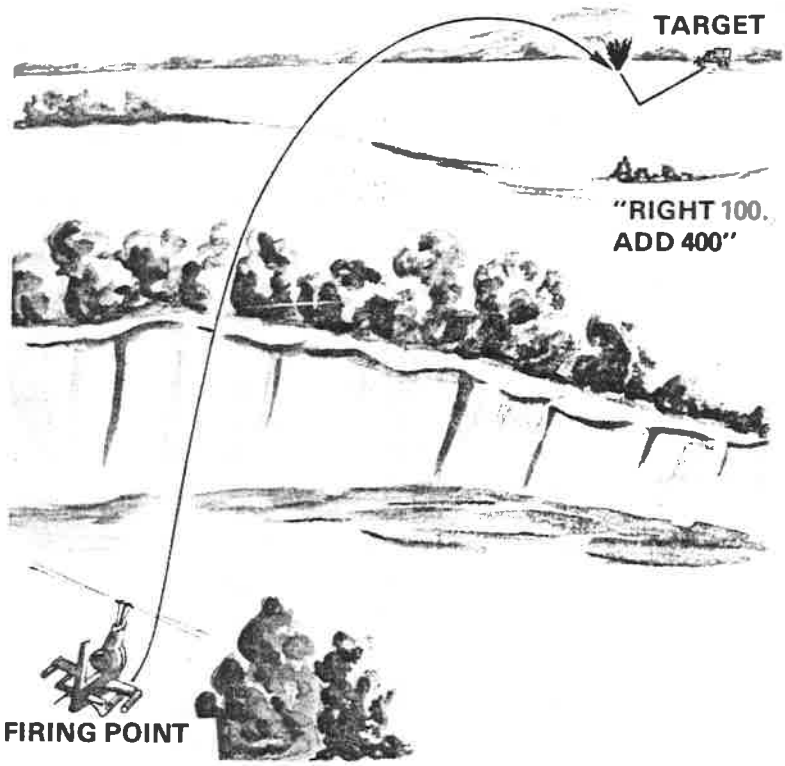
To determine the deflection correction, the rule of thumb that 1° heading change will move the impact point of the rocket approximately 20 meters at 1,000 meters is used. In the example above, it is determined that 1° will move the impact point 70 meters (20 x 3.5). Because the scale on the heading indicator cannot be read accurately, adjustment of less than 1° cannot be made.



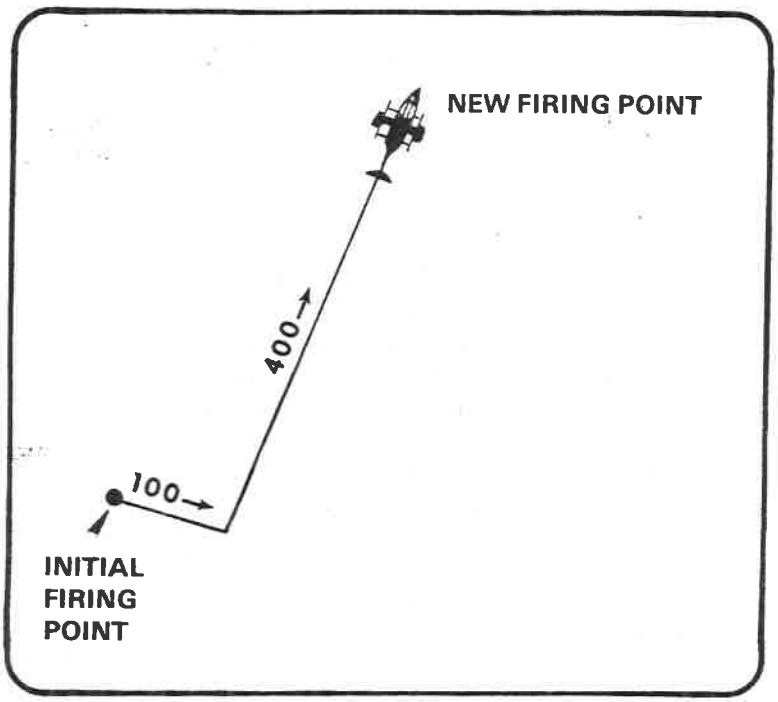
A 1° CHANGE OF HEADING RESULTS IN A LEFT OR RIGHT SHIFT OF 20 METERS FOR EACH 1,000 METERS OF RANGE

Indirect Fire Adjustment Procedures (Stable Fire)

Corrections to adjust for indirect fire must be received from an observer. After receiving the observer's corrections, the aircrew correction is computed as previously discussed. For example, the aircrew correction is computed to be right 100, add 400.



To adjust for range and lateral error, the helicopter is moved from the original firing point right 100 meters and forward 400 meters. The target is engaged from the new firing position using the original heading.



WEAPONS SUBSYSTEMS

To achieve the maximum capability of the attack helicopter, the aircrew must know the capabilities and limitations of the weapons systems. This section discusses the capabilities and limitations of the weapons systems for the attack helicopter and specific NOE firing techniques for the 2.75-inch FFAR.

2.75-INCH FOLDING FIN AERIAL ROCKET (M200)

Capabilities and Limitations

The beaten zones for hover and running fire are approximately the same at near ranges (less than 3,000 meters), but at longer ranges the beaten zone for running fire is smaller than for hover fire. Table 4-2 compares the length of the beaten zone as a function of range for hover and running fire.

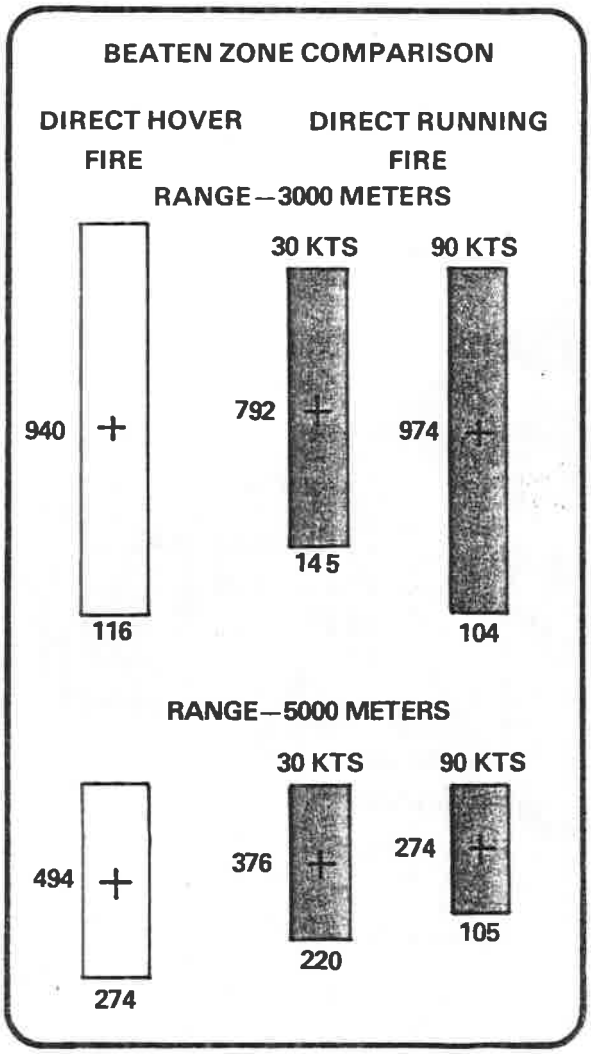


TABLE 4-2

The size of the beaten zone increases and the range achieved decreases when the quantity of rockets fired in a single salvo increases from four pairs to seven pairs of rockets. The size of the beaten zone is also affected by the rate of fire (milliseconds). High rates of fire allow the rockets to leave the rocket launcher closer together, thus improving the stability and decreasing the size of the beaten zone.

The range achieved for a given gunsight setting does not change when firing from altitudes between zero to 200 feet AGL.

When firing from a hover, rockets fired from the left side of the helicopter will land short of those fired from the right side. When hover fire is the primary mode of delivery, the QE of the right launcher should be set 6 mils below the left launcher when using a QE of 126 mils and 2 mils when using 103.5 mils to compensate for this trajectory error.

As a rule of thumb, a 5-mil change on the M73 gunsight will cause the rocket to move 100 meters in range.

Sight Cards

When firing the 2.75-inch FFAR direct fire, the attack helicopter aircrew should use the mil setting identified on the sight card for the appropriate airspeed, range, and launcher quadrant elevation (QE) settings. To achieve greater accuracy when using the sight card, the ballistic correction should be computed by firing the weapon and applying it to the mil setting identified on the sight card.

The sight card is computed for a 10-pound warhead. A lighter or heavier warhead will cause the rocket to impact either beyond or short of the target, respectively. The sight card is being developed for the 17-pound warhead and will be published when the results of testing are made available.

The standard turret configuration for computing the sight card is 2,000 rounds of 7.62mm ammunition and 125 rounds of 40mm ammunition (1/2 turret load). When firing the 2.75-inch FFAR with a greater or lesser amount of ammunition stored in the turret, the rocket will impact at a shorter or longer range than what is identified on the sight card.

The sight cards are computed for a gross weight of approximately 9,200 pounds. When firing the 2.75-inch FFAR from a hover with a lighter or heavier gross weight, the rockets will impact either at a shorter or longer range than what is identified on the sight card.

WHEN USING THE M73 GUNSIGHT, USE THE SIGHT CARD.

DISTANCE	AIRSPEED 0 KTS			30 KTS			60 KTS			90 KTS			120 KTS		
	QE 103	126	150	QE 103	126	150	QE 103	126	150	QE 103	126	150	QE 103	126	140
1,000	-84	-106	-120	0	-28	-25	-5	-20	-33	-35	-32	-50	-64	-68	-78
1,500	-73	-95	-109	13	-15	-17	7	-10	-17	-20	-23	-35	-52	-60	-67
2,000	-60	-83	-97	28	0	-5	25	4	-5	-3	-10	-18	-37	-46	-52
2,500	-43	-66	-80	45	17	10	42	22	12	13	5	-2	-19	-28	-34
3,000	-22	-44	-58	65	40	32	62	45	28	32	22	15	2	-7	12
3,500	+4	-19	-33	90	68	57	86	70	55	54	48	37	26	17	11
4,000	+34	+12	-2	125	95	87	113	95	80	80	73	57	52	42	37
4,500	+71	+49	+35	150	125	117	140	122	110	105	97	87	79	70	64
5,000	+116	+94	+80	180	150	150	168	148	145	132	123	127	109	100	93
5,500	+172	+149	+135	207	177	180	195	173	182	160	148	170	141	132	123

WHEN USING THE ATTITUDE INDICATOR, USE THESE TABLES.

INDIRECT RUNNING FIRE
DELIVERY AIRSPEED-60 KTS
LAUNCHER QE-150 MILS

DESIRED RANGE	PITCH ATTITUDE
3,500	5°
4,500	9°
4,950	15°

INDIRECT HOVER FIRE
8.4°
LAUNCHER QE-150 MILS

DESIRED RANGE	PITCH ATTITUDE
3,600	0°
4,800	5°
6,300	10°

18.4°

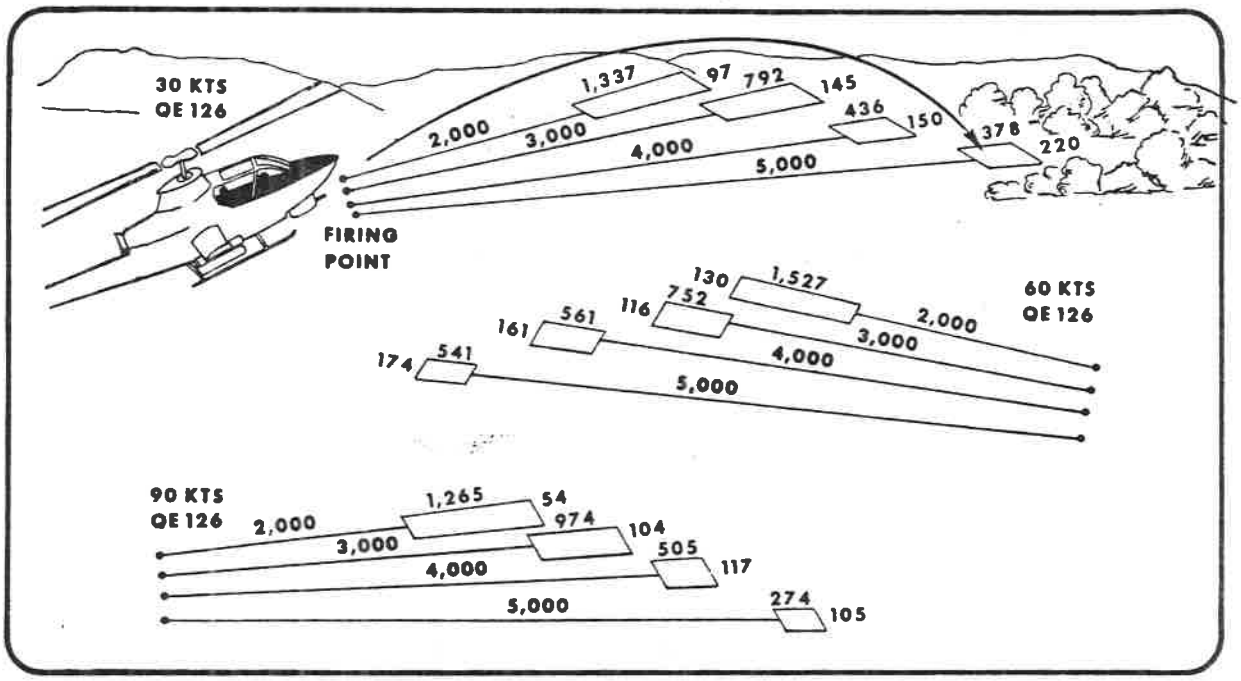
WHEN FIRING FROM A STABLE HOVER, A LAUNCHER QE OF 126 MILS WILL ACHIEVE A RANGE OF 3,049M; A QE OF 150, A RANGE OF 3,608M

Delivery Techniques

The 2.75-inch FFAR can be used to fire either direct or indirect fire using either the running or hover fire. Delivery techniques for each of these conditions are discussed in detail earlier in this chapter.

Direct running fire is the most accurate delivery technique when firing the 2.75-inch FFAR at NOE altitudes. When firing at midranges or less (2,500 meters), the beaten zone is extremely long and narrow. As the engagement range increases, the length of the beaten zone decreases regardless of the airspeed or rocket launcher QE. A disadvantage of this delivery technique is that the helicopter will gain altitude. This gain in altitude varies depending on the airspeed, the launcher QE, and the engagement range. A maximum average gain of 67 feet will be achieved using the launcher QE of 126 mils, an airspeed of 90 knots, and when firing at a range of 4,500 meters.

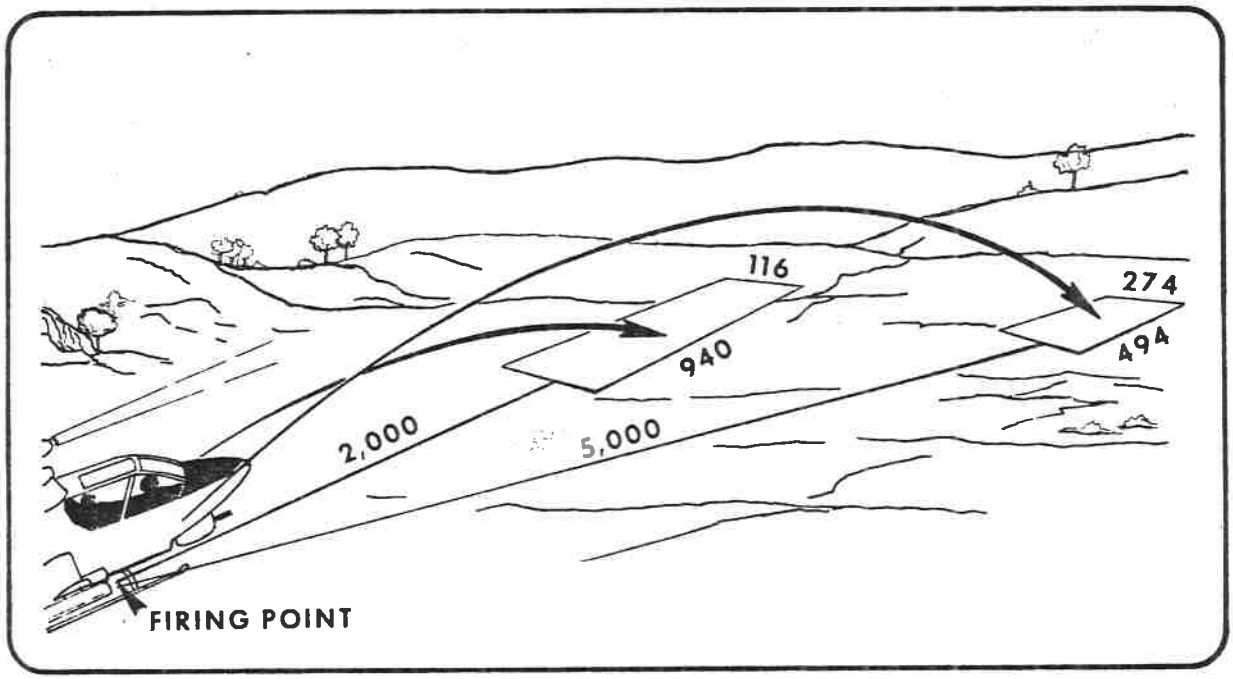
The beaten zone for indirect fire is larger than the beaten zone for direct fire when engaging targets at comparable ranges. To obtain the desired effect on a target, an observer is required to adjust the impact of the rocket on the target. When observed



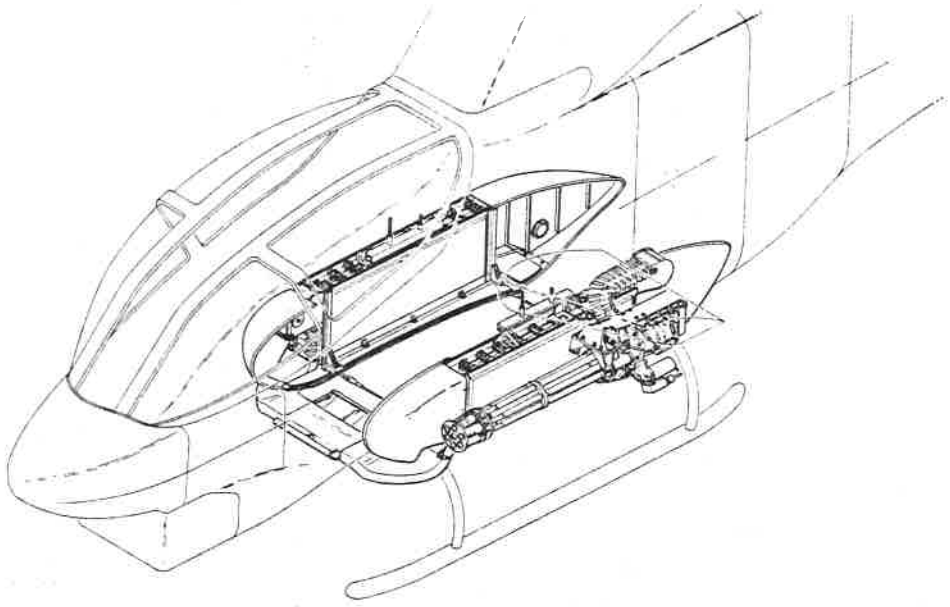
When performing direct hover fire, the nose-high attitude necessary to achieve the extended range requires that maximum power be used to perform a recovery leaving little or no power in reserve. The helicopter is unsteady when transitioning from a stationary hover to a nose-high attitude and recovering to a stabilized hover. Greater accuracy is achieved by firing out-of-ground effect because the air around the helicopter is less turbulent than when hovering in-ground effect. Another hover fire consideration is that the average length of the beaten zone decreases as range increases; however, the width of the beaten zone increases as the range increases.

fire cannot be used, greater accuracy is achieved using the aircraft attitude and heading indicator to obtain a firing attitude. If an observer is used to adjust fire, the best procedure is to use the M73 gunsight and adjust using a distant reference point.

The indirect hover delivery technique is less accurate than direct running fire. Both the stable and pitching technique can be used to engage targets using indirect hover delivery techniques. To achieve the best effect on a target, an observer is required for adjustment.



20MM CANNON (M35)



Capabilities and Limitations

The firepower provided by the 20mm cannon gives the aircrews of the attack helicopter a standoff capability against enemy small arms and some antiaircraft weapons. The high muzzle velocity and rate of fire enable the aircrew to place large volumes of accurate fire on the target with minimum exposure time. With improved projectile fuzing, the weapon system will provide the aircrew a greater capability for tactical operations in a high threat environment.

The most significant limitation of this weapon system is the fact that there are several factors that will prevent the fuze from functioning properly. The existing fuze mechanism for the 20mm projectile is a point detonating type which requires a very high impact force to cause detonation. Beyond 1,500 meters, the round normally will not have the velocity required to provide sufficient impact force for detonation. Even when fired within its effective range, low angles of impact may cause the round to ricochet rather than detonate. This is critical when firing from NOE altitudes. Regardless of the range, the fuze functioning is directly affected by the type of target being engaged. Projectiles striking hard, flat plate surfaces (buildings, armor vehicles) have a higher probability of detonation than soft targets such as personnel in open areas.

Structural damage is common due to the recoil of the weapon system. Inspection of the wingstores mounting brackets should be conducted before and after each mission when the 20mm cannon has been fired.

The 20mm cannon produces a large muzzle flash. When firing at night, it is easily recognizable and may cause the aircrews to lose their night vision.

When firing the 20mm cannon at a hover, carbon is expelled and is sucked into the engine inlet causing loss of power.

M35 Sight Card

To achieve greatest accuracy when using the sight card, the ballistic correction for the weapon should be computed by firing the weapon and applying it to the mil setting for the desired range. Factors which must be considered when using the sight card are:

The loading configuration of the helicopter for computing the sight card is based on a one-half ammunition load in the turret.

The quadrant elevation (QE) of the gun pods must be set at +84 mils.

Based on the above conditions, a range of 1,500 meters is achieved when firing from a stabilized hover. Targets that are engaged beyond or short of this range require a pitch attitude change to hit the target. The range at which the projectile will impact while firing from a stationary hover can be adjusted by changing the QE of the gun pods. For example, by adding +18 mils (84 + 18 = 102 mils) to the QE, a range of 2,000 meters can be achieved when firing from a stabilized hover. If a target is to be engaged at another range with the gun pods set at 102 mils, 18 mils must be either added or subtracted depending on the range to the target from the mil setting on the sight card or a new sight card developed for the QE set on the gun pods.

HOVER		
500m	-	30 mils
1,000m	-	18 mils
1,250m	-	9 mils
1,500m	+	0 mils
2,000m	+	18 mils
2,500m	+	39 mils
3,000m	+	95 mils

Delivery Techniques

The ability of the aircrew to place effective fire on the target with minimum expenditure of ammunition in the least amount of time is dependent upon the accuracy of the boresight, the establishment of an accurate combat sight setting for diving fire or ballistic correction for terrain firing, and accurate range estimation. Initial engagement of a target for diving fire and terrain firing is the same as previously discussed. Subsequent adjustments to place the projectile onto the target are accomplished by using the walk-on method. Up to 1,500 meters, tracer fire provides the best method of walking the projectile onto the target. In order to use tracers to adjust, the helicopter must be on higher ground shooting down or the engagement range short enough for the trajectory to be below the horizon. The use of tracers to adjust fire has the disadvantage that the helicopter's position is disclosed to the enemy. At ranges greater than 1,500 meters, burst on target (BOT) provides the aircrew the best means of adjusting the projectile onto the target. As range increases, adjustments become more difficult due to the poor probability of fuze functioning.

Greater accuracy is achieved when firing the 20mm cannon during running fire, using direct fire delivery techniques. Airspeed above 40 knots provides a more stable platform for firing; however, airspeeds between 110 to 120 knots should be avoided. When transitioning between these airspeeds, a yawing effect is experienced. This is caused by excessive antitorque inputs at the same time the cambered vertical fin begins to develop effective heading control.

The 20mm cannon can be effectively employed to engage targets while at a hover. A yaw to the left must be anticipated and sufficient antitorque pressures applied to align the gunsight on the target.

40MM GRENADE LAUNCHER (M129)

Capabilities and Limitations

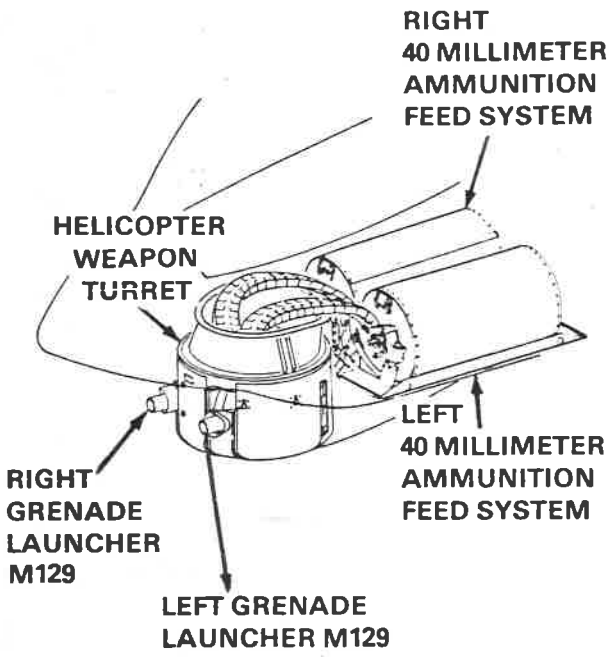
The diversified mission of the attack helicopter requires that it be armed with an effective antipersonnel weapon system. This capability is provided by the M129 grenade launcher. The system is especially adaptable for terrain flight firing because it is accurate at short ranges, provides excellent suppressive fire, and has a flex capability which enables the aircrew to suppress enemy positions without overflying the target.

The muzzle velocity of this projectile is relatively slow. When engaging targets at ranges beyond 500 meters, the helicopter must unmask for a long period of time to accurately adjust by fire on the target. The requirement to adjust fire is normally a result of inaccurate range estimation to the target. If the aircrew knows the correct range, first-round hit probability is good up to 1,600 meters.

The dispersion of the weapon system is good. For point targets, a 20-meter square will contain approximately 50 percent of the rounds when firing at targets up to 1,600 meters.

The range of the gun is limited by the elevation flexible limits of the M28A1 turret system which is 18° at the 12 o'clock position and 10.6° at the full azimuth deflection of 107.5°. The elevation limits remain constant; however, the attitude of the helicopter varies based upon the load configuration and the airspeed. The maximum range that can be achieved while conducting running fire is 1,600 meters. When firing from a hover, targets can be engaged up to 2,000 meters. These ranges may be less, based upon turret loading.

When firing from terrain flight altitudes, greater accuracy can be achieved



using hover fire and limiting turret movement to 15° either side of center position. This delivery technique minimizes the yaw and tuck effects that are encountered when firing at greater deflection angles.

Increased ranges can be achieved by firing the grenade launcher in the stowed mode and adjusting the pitch attitude to obtain the desired range.

Delivery Techniques

There are no delivery techniques peculiar to this weapon system for terrain flight. The normal aiming of the weapon is accomplished by superimposing a reticle image on the target for the appropriate range. Testing is being conducted to determine innovative delivery techniques. The findings of these tests will be reported as the information is made available.

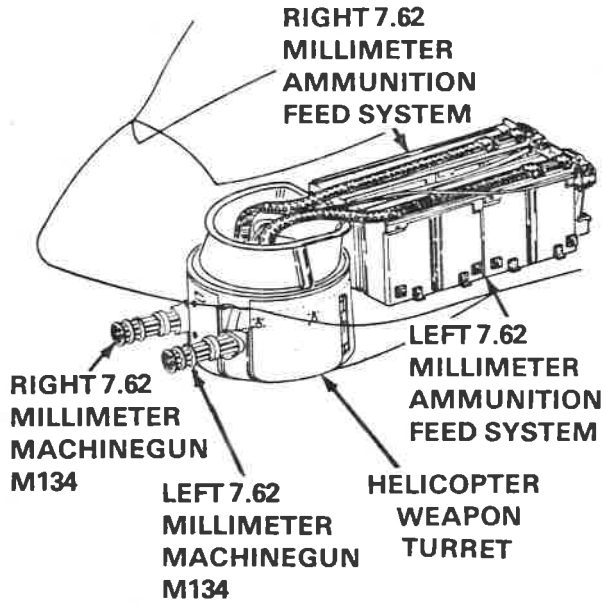
7.62MM MACHINEGUN (M134)

Capabilities and Limitations

When flying at terrain flight altitudes, the attack helicopter is vulnerable to small arms fire. Even though the exposure time of the helicopter is of short duration from a point along the flightpath, firepower is required to neutralize or suppress the enemy weapon. The high rate of accurate fire and flex capability of the turret mounted 7.62mm machinegun provides the attack helicopter aircrew the defensive capability required to operate in the high threat environment.

The range of the weapon is dependent upon the delivery technique employed and the desired effect on the target. The maximum effective range of the system is 1,100 meters. This range is approximately 200 meters beyond tracer burnout; however, accurate adjustment can be made to place effective fire on the target after tracer burnout by estimating trajectory impact and burst on target effect. Maximum ranges up to 2,500 meters can be achieved firing from a hover with maximum elevation of the turret. Accuracy at maximum range is poor and target effect is ineffective due to the low impact velocity of the projectile.

The reliability of the weapon is degraded by the frequent stoppages that may occur when employing the gun. A malfunction of the weapon renders that particular weapon system inoperative for the remaining portion of the flight. The other weapon system in the turret is not affected by the weapon which has malfunctioned; however, the weapons switch selector should be placed in the position to select the operational weapon. Procedures which the aircrew and maintenance crew can use to reduce weapon stoppage are:


RIGHT 7.62 MILLIMETER AMMUNITION FEED SYSTEM
LEFT 7.62 MILLIMETER AMMUNITION FEED SYSTEM
RIGHT 7.62 MILLIMETER MACHINEGUN M134
LEFT 7.62 MILLIMETER MACHINEGUN M134
HELICOPTER WEAPON TURRET

Use a high rate of fire when firing the weapon. More stoppages are experienced when firing at the low rate of fire.

When one machinegun is used in the M28 turret, mount it on the right side of the turret. This procedure aids the ammunition-feeding mechanism by providing gravity assist.

Use designated M134 machinegun ammunition. Although regular M60 machinegun ammunition can be fired with the M134 machinegun, the link is weaker and subject to breaking when fired in the M28 armament system.

Delivery Techniques

There are no delivery techniques peculiar to this weapon system for terrain flight. The normal aiming of the weapon is accomplished by superimposing a reticle image on the target for the appropriate range. Testing is being conducted to determine innovative employment techniques. The findings of these tests will be reported as the information is made available.

SUMMARY

In a high threat environment, aircrews of the attack helicopter must be capable of engaging targets at terrain flight altitudes. There are three types of fire: diving, running, and hover. Because diving fire must be fired from altitude, it cannot be employed in a high threat environment. Terrain firing delivery techniques using hover fire and running fire can be used to conduct either direct or indirect fire. To engage a target using direct fire delivery techniques requires that the gunner place the required mil setting for the desired range on the target and adjust the altitude of the helicopter until the sight reticle (pipper) is on the target. To hit a target using indirect fire delivery techniques, the altitude indicator or the distance aiming point is used. When using the attitude indicator, the heading indicator is used to determine the correct heading to the target. A third method (stable hover fire) may be used; however, it has the limitation that only one range can be fired.

To achieve the desired effect on a target, the aircrew must be capable of adjusting the impact point of the projectile on the target. When using direct fire delivery techniques, the aircrew can determine the range and lateral error by observing the impact of the round in relation to the target. Using a rule of thumb that a 5-mil change in elevation will move the impact point of a 2.75-inch FFAR 100 meters, accurate range adjustments can be made. Lateral correction is made by displacing the pipper either left or right of the target. When conducting indirect fire, an observer must provide corrections to the aircrew. To use observer corrections, other than gun-target line corrections, the dead reckoning computer is used to determine firing data. After the firing data is computed, the aircrew must determine the number of mils or degrees required to correct for range and apply the correction to the gunsight or attitude indicator. To compute lateral correction in mils, the aircrew can use the dead reckoning computer. When using the heading indicator to correct for lateral error, use the rule of thumb that a 1-degree change will move the impact point of the rocket 20 meters at 1,000 meters. To adjust for range and lateral error when using the stable hover delivery technique, the helicopter is moved from the firing position an amount equal to the lateral and range error.

The capabilities and limitations of each weapon subsystem for the attack helicopter will determine the delivery technique that is employed and its effectiveness in a high threat environment. To insure survivability of the helicopter and destruction of the target, aircrews must evaluate these factors before engaging a target.

CHAPTER FIVE

ATTACK HELICOPTER TACTICAL EMPLOYMENT CONSIDERATIONS

INTRODUCTION

The employment of the attack helicopter units is directed by unit commanders; however, the actual conduct of the battle is performed by the aircrews of the attack helicopters. Even though the commander may use sound principles for employing the attack helicopter, unless the aircrew understands the *how, when, where,* and *why* of performing a combat mission, the probability of success is significantly reduced. This chapter addresses specific considerations that aircrews must be familiar with in order to effectively employ the attack helicopter. Although it is primarily directed at the individual aircrew, information is presented which would be used by the flight leader in making his decisions. Even though the individual aircrews may not participate in decisionmaking, they have a need to know specific information relating to the mission. Specific reference is not made to a particular type attack helicopter unit because each consideration is applicable to all units possessing attack helicopters. Although the factors that an aircrew must consider are presented in chronological order, in the actual conduct of the mission one or more events may be accomplished concurrently.

PRINCIPLES OF EMPLOYMENT

FM 90-1, Employment of Army Aviation Units in a High Threat Environment, contains a general discussion of the principles of employment that each aircrew must consider when planning and conducting a tactical mission. These principles constitute a collection of commonsense ideas that must be understood in their entirety, but all are not necessarily applicable in every case. Their application must be carefully evaluated and tailored for each situation. Emphasis may be placed on one or more of the principles in any particular situation. A balance of these principles should be used by the aircrew to successfully employ the attack helicopter. *BY PROPERLY APPLYING THE PRINCIPLES, THE AIRCREW CAN ATTAIN OPTIMUM EFFECTIVENESS, MINIMIZE VULNERABILITY, AND MAXIMIZE SURVIVABILITY.*

Mere knowledge and understanding of the principles of employment will not provide the solution to every problem of war. The human elements — courage, morale, discipline, and leadership—have a direct bearing on the outcome of any operation and are so vital to success that they deserve constant attention. In the final analysis, sound judgment and commonsense are always of vital importance to the successful application of the principles of employment.

The Thirteen Principles of Employment

1. Fight integrated on the combined arms team.
2. Exploit capabilities of other services.
3. Capitalize on intelligence-gathering capabilities.
4. Suppress enemy weapons and acquisition means.
5. Exploit firepower.
6. Exploit mobility.
7. Integrate fire and maneuver.
8. Employ surprise.
9. Mass forces.
10. Utilize terrain for survivability.
11. Displace forward elements frequently.
12. Maintain flexibility.
13. Exercise staying power.

PREMISSION PLANNING

The difference between defeat and victory on the battlefield is often determined by the amount of planning that was conducted prior to the execution of the mission. This is particularly true when employing large numbers of attack helicopters over vast battle areas. Of equal importance is informing the aircrews within the flight of pertinent information they need to perform crew planning. Normally, prior to receiving a mission, the aircrews will receive a warning order. At that time, the unit SOP will dictate what action is required by the aircrew. After the flight leader has carefully planned the mission, he should present a flight briefing which contains:

THOROUGH PREMISSION PLANNING IS THE KEY TO MAINTAINING FLEXIBILITY AND ACHIEVING MISSION SUCCESS.

➡ *Mission.* When, where, and what type of targets will be engaged.

➡ *Enemy situation.* Posture of the enemy, i.e., offense, defense, reinforcing, and location of known forces.

➡ *Air defense weapons.* Location and type of enemy air defense weapons that may affect the operation. Also the activity of enemy tactical air.

➡ *Weather.* Forecast weather conditions in the operational area throughout the period of operation.

➡ *Logistical support.* Location of the FARRP and anticipated period of operation.

➡ *Tactical air and artillery support.* Location and time of planned suppressive fires and availability of tactical air. Location, frequencies, and rules of engagement for friendly air defense.

➡ *Communication.* Frequencies, call signs, CEOI procedures, IFF transponder codes, and communication discipline to be used.

➡ *Command and control.* Identify en route procedures, proposed holding areas, attack route, attack positions, and procedures to be used for target handoff and target designation. The flight leader will identify his position within the flight (e.g., aircraft commander, scout helicopter).

AIRCREW PLANNING

After receiving the flight leader's briefing, the aircrew must conduct their premission planning which includes:

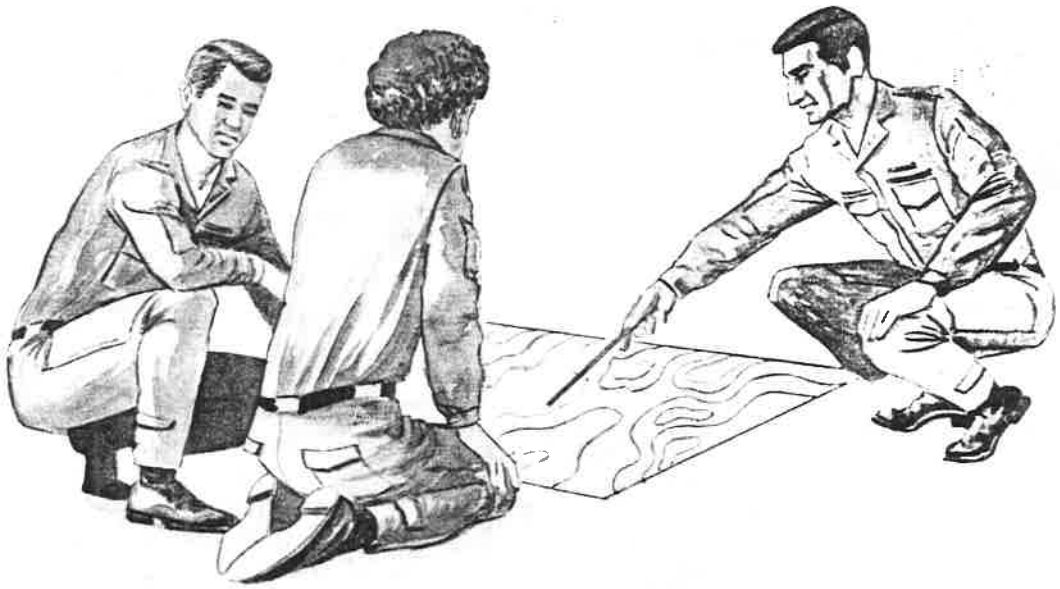
➡ *Map reconnaissance.* Each aircrew will perform a map reconnaissance of the proposed attack routes and attack positions. Using the consideration for selection of attack routes and attack positions discussed in this chapter, tentative routes of flight and the flight attack position should be marked on the map.

➡ *Compute weight and balance.* Based upon the mission requirements, i.e., time of flight, density altitude, and ammunition requirement, the aircrew must compute the weight and balance to determine the capability of the helicopter to perform the mission. A power check will be performed prior to takeoff to verify the information computed in the operator's manual.

➡ *Preflight.* A thorough preflight of the helicopter and its armament systems should be conducted by the aircrew to include engine start. Power should be applied to each weapon system that has a built-in test capability to determine its operational status.

➡ *Night operations.* When the mission is to be conducted at night, aircrews should avoid illuminated areas. Preferably, the premission briefing is conducted in a room equipped with red lights. Preflight should be conducted during daylight hours. (More detailed information, relating to night flight is contained in TC 1-28, Rotary Wing Night Flight.)

➡ *Rehearsal.* If sufficient time is available, aircrews and the flight leader should conduct a detailed map rehearsal of the operation. Positions for each aircrew within the flight will be designated; radio calls will be practiced; and occupation and departing firing positions will be discussed. Scout helicopter crews should participate in the rehearsal. When time doesn't allow the aircrews to conduct a rehearsal, the flight leader should include more detailed information in the premission briefing.



CONDUCT A MAP REHEARSAL WHENEVER POSSIBLE.

TARGETS OF OPPORTUNITY

The flexibility of the attack helicopter permits rapid deployment throughout the battlefield. Because the attack helicopter can be employed rapidly, aircrews will not always have the opportunity to plan a mission in detail as discussed previously. For example, a flight of attack helicopters may be waiting in the holding area when a scout aircrew acquires a target. Upon receipt of a mission, the flight is ready for takeoff. To compensate for the lack of time to plan for the mission, multiple preplanned attack routes should be selected and coordinated with the scout aircrew. Other planning factors such as preflighting the helicopter and map reconnaissances can be performed while waiting for a mission.

Upon receiving a mission from the scout aircrew, the flight leader would be told which attack route to follow. The flight may be designated an attack position; however when possible, the scout helicopter aircrew will guide the flight to the attack position. Even though the where and when of a mission is not known, the preplanning an aircrew performs will contribute to the success of the mission.

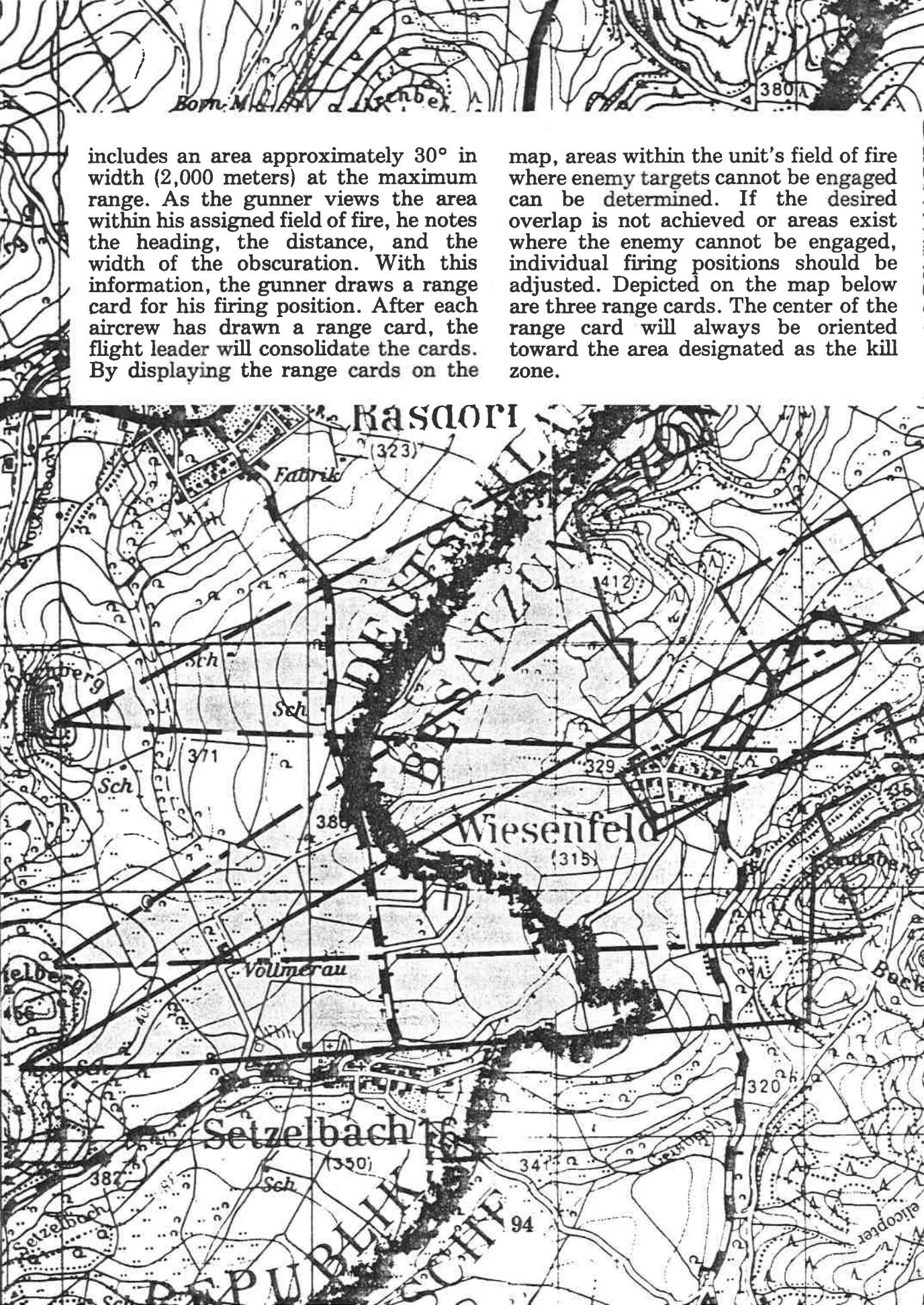
IMMEDIATE REACTION

During the conduct of a mission, whether it is a preplanned mission or a target of opportunity, an aircrew may encounter a target or a threat weapon which requires immediate action to gain a tactical advantage. The nature of the target may be that it is of higher priority than the target which the attack helicopter is en route to engage. If it is a threat weapon (e.g., tactical aircraft, air defense gun, or missile), the situation would require that it be destroyed or that it be evaded in order to continue the mission. In either situation, failure to initiate immediate action by the aircrew will give the enemy the advantage. The decision is a judgment made by the aircrew based upon the priority of the target and threat encountered. Action initiated by the aircrew must be reported when the tactical situation permits.

DEFENSE

During the conduct of an offensive operation, the attack helicopter aircrew must move about the battlefield in search of targets, over unfamiliar terrain, while subject to detection and engagement by enemy threat weapons. When employed in the defense, aircrews can move over familiar terrain into attack positions and engage targets from firing points that provide the best cover and concealment. Also, the threat of being engaged by enemy air defense weaponry or tactical air is minimized. Prior to actually engaging the enemy, the force commander will have planned the defensive positions for the unit. Primary and alternate attack positions will be designated for the attack helicopter units as part of the defensive plan. Upon being assigned a defensive mission, the attack helicopter unit must conduct a reconnaissance of the assigned attack positions and select attack routes into and out of the area and individual firing position. The considerations for selecting attack routes, attack positions, and firing positions are the same as discussed for offensive operations. After the firing positions are selected, each aircrew should develop a range card. The purpose of the range card is to determine if there are areas within the field of fire of each firing position where the enemy cannot be engaged. The range card is developed by the gunner sighting through the telescopic sight of the TOW missile system to observe areas that are obscured by terrain features. The area of concern extends 500 meters from the helicopter out to the maximum range of the rockets or the TOW missile system (3,750 meters). The lateral coverage

includes an area approximately 30° in width (2,000 meters) at the maximum range. As the gunner views the area within his assigned field of fire, he notes the heading, the distance, and the width of the obscuration. With this information, the gunner draws a range card for his firing position. After each aircrew has drawn a range card, the flight leader will consolidate the cards. By displaying the range cards on the map, areas within the unit's field of fire where enemy targets cannot be engaged can be determined. If the desired overlap is not achieved or areas exist where the enemy cannot be engaged, individual firing positions should be adjusted. Depicted on the map below are three range cards. The center of the range card will always be oriented toward the area designated as the kill zone.



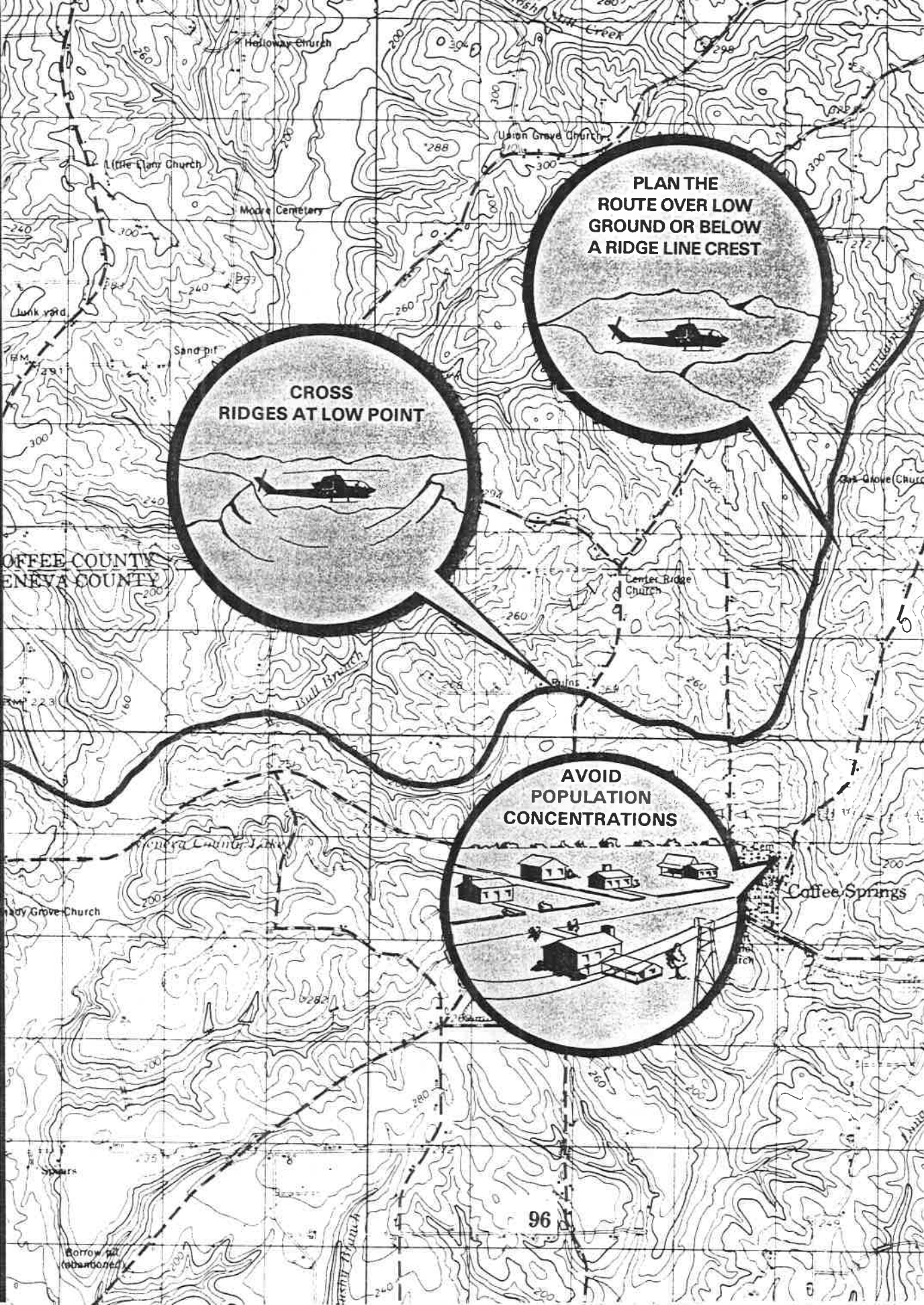
ROUTE PLANNING CONSIDERATIONS

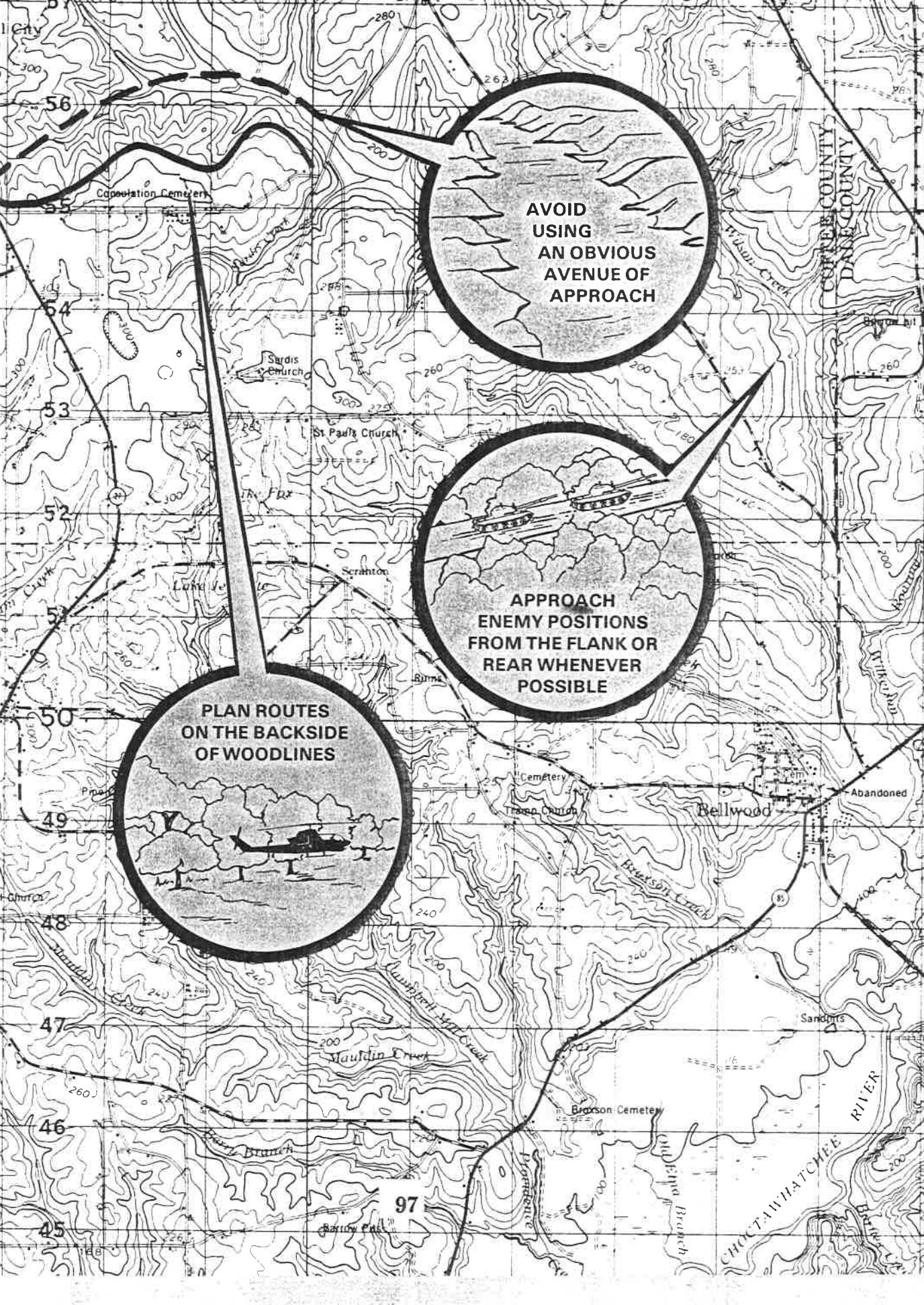
When selecting a route, the aircrew is actually planning detection avoidance and must make maximum use of the principle of cover and concealment. To do this, the aircrew must know the local enemy threat and how he has been employing his air defense weapons systems. Routes can then be planned to keep the highest possible terrain and/or thickest vegetation between the enemy and helicopter. To do this in mountainous or rolling terrain, plan the route on the friendly side and below the crest of a ridgeline. In very gently rolling terrain, plan the route across the low terrain such as streambeds where it does not serve as an avenue of approach to the enemy position. In arid or open areas, plan the route along streambeds or depressions where trees may exist. When feasible, routes should avoid population concentrations due to the large number of hazards. Routes should not follow manmade linear features such as roads, canals, or pipelines unless required because of restricted visibility. These linear features normally do not follow a course which offers the greatest masking opportunity. To the maximum extent possible, routes should be planned over heavily vegetated areas as opposed to open terrain. This is especially true near enemy positions because the vegetation further restricts the ability of the enemy to detect the helicopter. Also, by flying over vegetation the helicopter shadow, which is the primary means by which high performance aircraft visually locate low flying helicopters, can be broken and lost in the darker vegetation. Because helicopters are susceptible to radar or visual detection on the side of a slope facing the enemy regardless of altitude, ridgelines should be crossed at low points and as rapidly as possible to reduce exposure time to a minimum and to avoid silhouetting the helicopter on the horizon. Plan primary and alternate routes into and out of the objective area.

Checkpoints used along a route should be terrain features in preference to manmade objects. This is because manmade features are subject to change or destruction and unplotted features may be confused for intended checkpoints. When manmade objects are used, they should be used primarily to help confirm the identity of terrain features.

Specific altitude restrictions should be determined for each route. When operating within range of enemy air defense weapons, maximum altitude is determined based on the masking offered by available terrain and vegetation. When operating beyond the range of enemy air defense weapons but within range of enemy surveillance equipment, altitude is determined based on friendly tactical considerations such as airspace management for aircraft, artillery, and air defense weapons. Friendly tactical

ROUTE PLANNING CAN ONLY BE AS GOOD AS THE MAP IS ACCURATE. IN SOME CASES, WE MAY BE WORKING WITH AN OUT-OF-DATE MAP OR MAPS ON WHICH THE CONTOUR INTERVAL IS TOO LARGE TO SHOW TERRAIN RELIEF ADEQUATELY; THEREFORE, CHANGES TO THE ROUTE, BASED ON OBSERVATION OF THE ACTUAL TERRAIN, SHOULD BE MADE IF NECESSARY TO REMAIN MASKED.


PLAN THE ROUTE OVER LOW GROUND OR BELOW A RIDGE LINE CREST
CROSS RIDGES AT LOW POINT
AVOID POPULATION CONCENTRATIONS
Holloway Church
Little Clam Church
Moore Cemetery
Union Grove Church
Junk yard
Sand pit
Center Ridge Church
Bull Branch
Coffee Springs
Borrow pit (abandoned)


AVOID USING AN OBVIOUS AVENUE OF APPROACH
APPROACH ENEMY POSITIONS FROM THE FLANK OR REAR WHENEVER POSSIBLE
PLAN ROUTES ON THE BACKSIDE OF WOODLINES
Copulation Cemetery
Sardis Church
St Pauls Church
Scranton
Bellwood
Abandoned
Cemetery
Training Canton
Broxson Cemetery
Sandhills
Mauldin Creek
Campbell Light Creek
Brooks Creek
Wilson Creek
Barry Branch
Barlow Ens.
CHOCTAWHATCHEE RIVER
COFFEE COUNTY
DALE COUNTY
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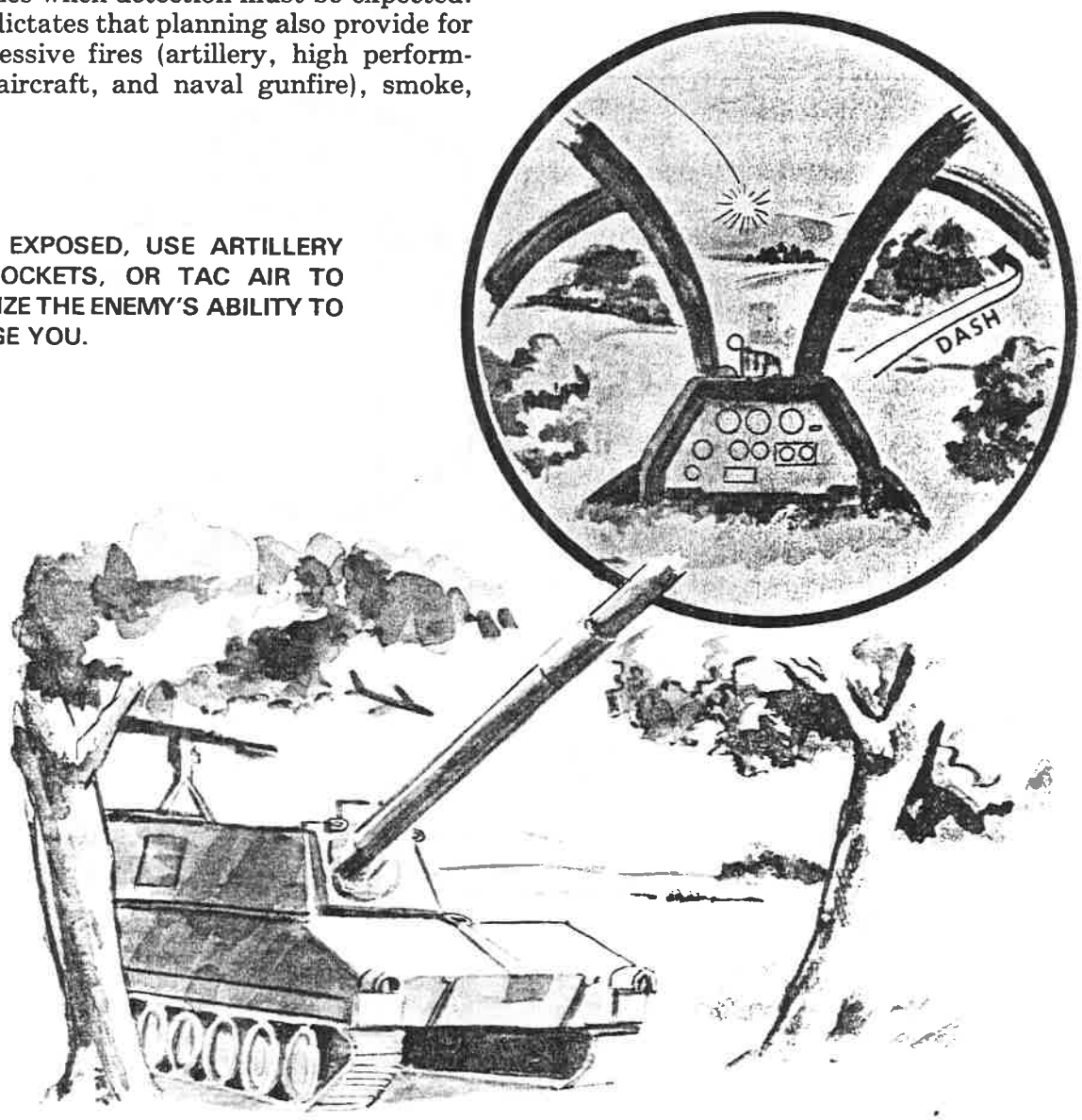
considerations also include counterintelligence considerations. For example, altitude should be below enemy surveillance capability in the vicinity of command posts (CP), assembly areas, forward area rearm and refuel points (FARRP's), to prevent enemy radar from locating these positions because of the high density of traffic in the areas.

Even when using NOE flight, there will be times when detection must be expected. This dictates that planning also provide for suppressive fires (artillery, high performance aircraft, and naval gunfire), smoke, chaff, standoff jamming, or any other means available which can prevent the enemy from locating and/or attacking the helicopter. Whenever operating inside or near the range of enemy air defense weapons and/or artillery, the need for suppressive fires should be considered and, if necessary, requested by the aircrew.

WHEN EXPOSED, USE ARTILLERY 2.75 ROCKETS, OR TAC AIR TO MINIMIZE THE ENEMY'S ABILITY TO ENGAGE YOU.



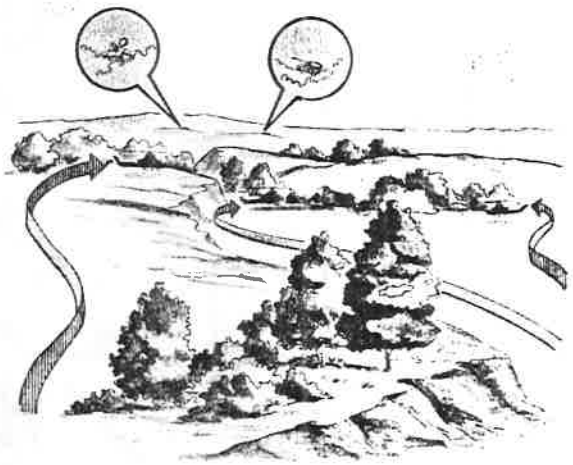
EN ROUTE CONSIDERATIONS

In the high threat environment, the formation used en route is defined by terrain, situation, and desired degree of control. Regardless of the specific formation, the helicopters will be staggered and the distance between helicopters will vary according to the terrain being crossed. Each aircrew in the flight is responsible for the accuracy of navigation and must be prepared to take the lead at anytime and proceed to the destination. Light signals and code words should be used to assist in reducing radio communications and in the event of lost communication or radio jamming by the enemy.

When terrain flying, the greater the number of helicopters in a group, the more easily they can be detected. In addition, a large group requires more terrain relief to remain masked than does a small group. When large groups of helicopters are required to accomplish the mission, dispersion can be achieved by using numerous routes into an area with small groups of helicopters utilizing each route. However, it will often be necessary to use a single route in order to concentrate limited suppressive fires.

When moving, a small team of two or three helicopters should normally maintain its integrity so as to return an adequate volume of fire if attacked. Units should employ traveling, traveling overwatch, and bounding overwatch techniques. When flying nap-of-the-earth, individual aircrews move as do individual infantrymen in a squad. The squad leader picks the general direction of travel but each infantryman picks his terrain and moves by rushes or bounds within the loose formation. He is not required to step in the footprints of every man ahead of him. With helicopter formations, following helicopters pick their own terrain, moving by bounds independently from point to point within

WHEN USING CONTOUR AND LOW LEVEL FLIGHT, INDIVIDUAL AIRCREWS MAINTAIN CONSTANT POSITIONS, BUT VARY DISTANCE.

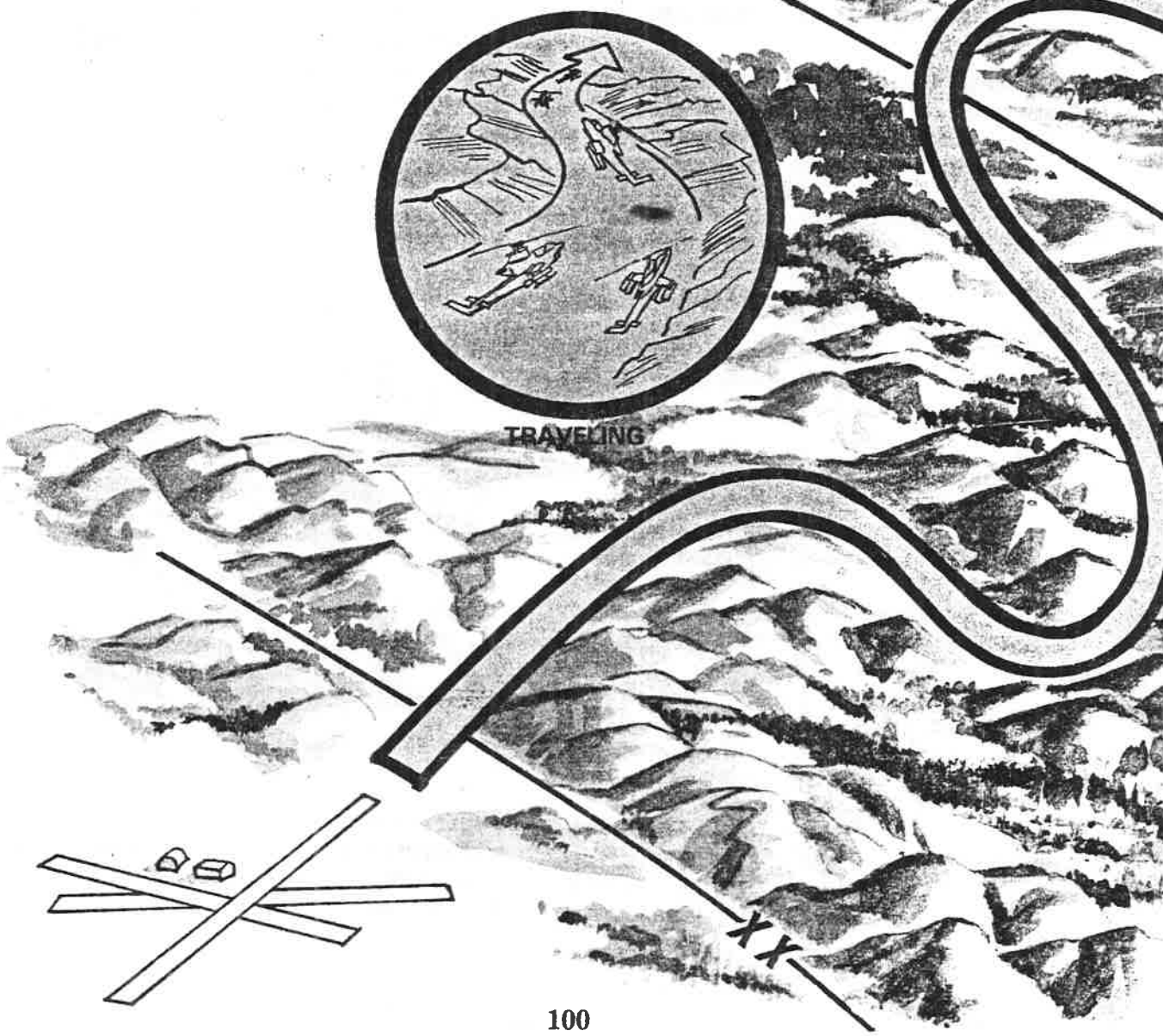


WHEN FLYING NOE, INDIVIDUAL CREWS OF A MANEUVERING UNIT "PICK" THEIR OWN WAY ALONG A COURSE ESTABLISHED BY THE LEADER.

the formation. The pilot must be particularly careful not to maintain standard distances from preceding helicopters or exact flight routes which can aid enemy gunners. Each pilot must be aware of the situation, the terrain, and the mission. He must not follow blindly the tailpipe of the helicopter ahead.

Traveling can be used when contact is not likely such as in corps and division rear areas. Low-level flight will most often be used when employing the traveling technique. During traveling NOE and contour flight, the unit will normally move in loose trail or staggered trail. When low-level flight is used, more formation flexibility is possible. The dispersion will be determined by the desired degree of control, visibility, terrain restrictions, and tactical considerations.

When contact is possible, traveling overwatch should be used. Traveling overwatch is characterized by continuous movement of the main elements (during an air assault operation, the lift platoons). The overwatch elements (the gunships) move at variable speeds and

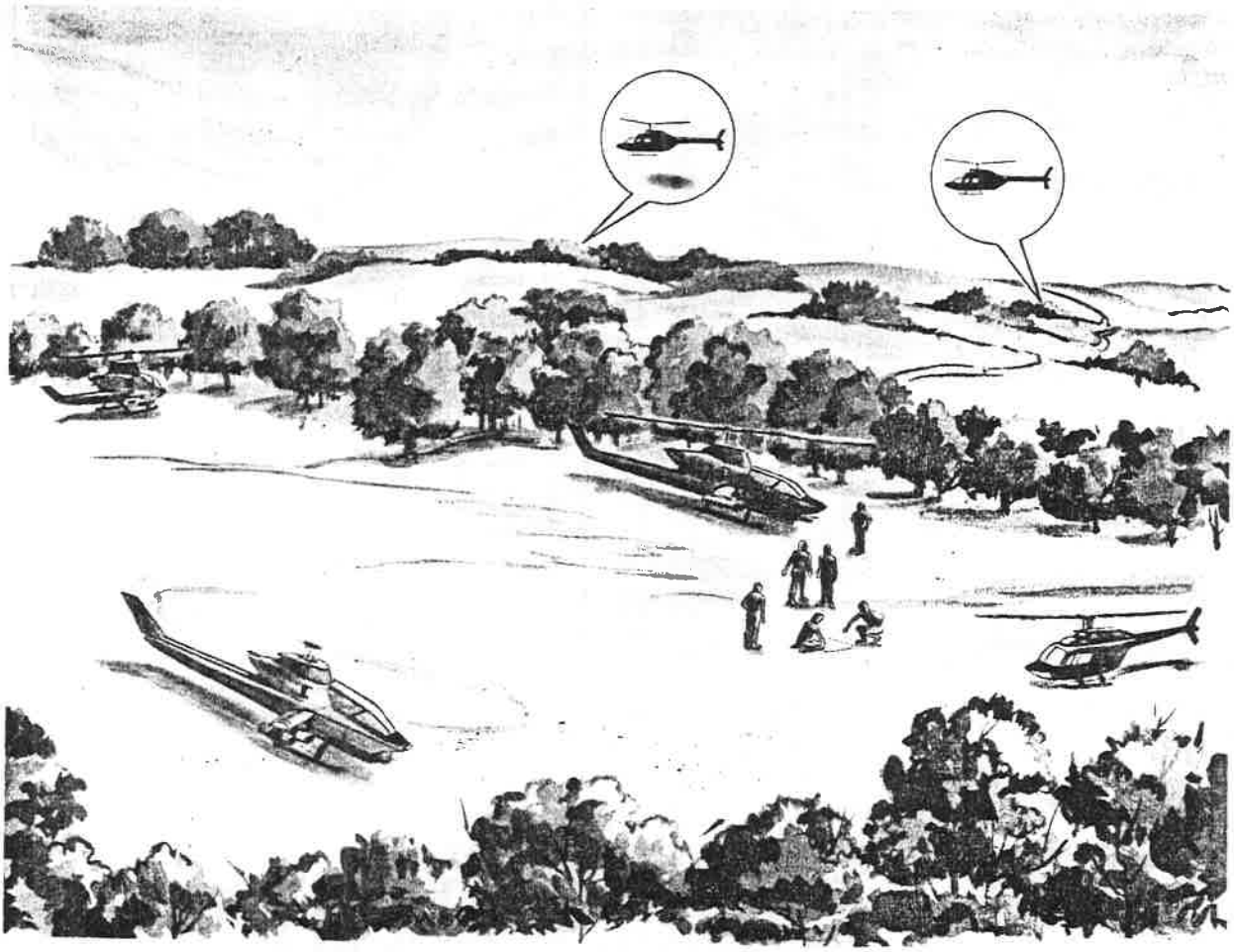


may even pause for short periods if necessary. The overwatching element keys its movements to the terrain and is always prepared to fire or maneuver, or both, to support the main elements.

At times it will be necessary for the aviation unit to employ a bounding overwatch. Elements move by bounds with one element in position to fire while the other element moves. Once in position, the bounding element becomes the overwatching element and vice versa. This technique will be especially applicable in a situation where enemy contact is expected.

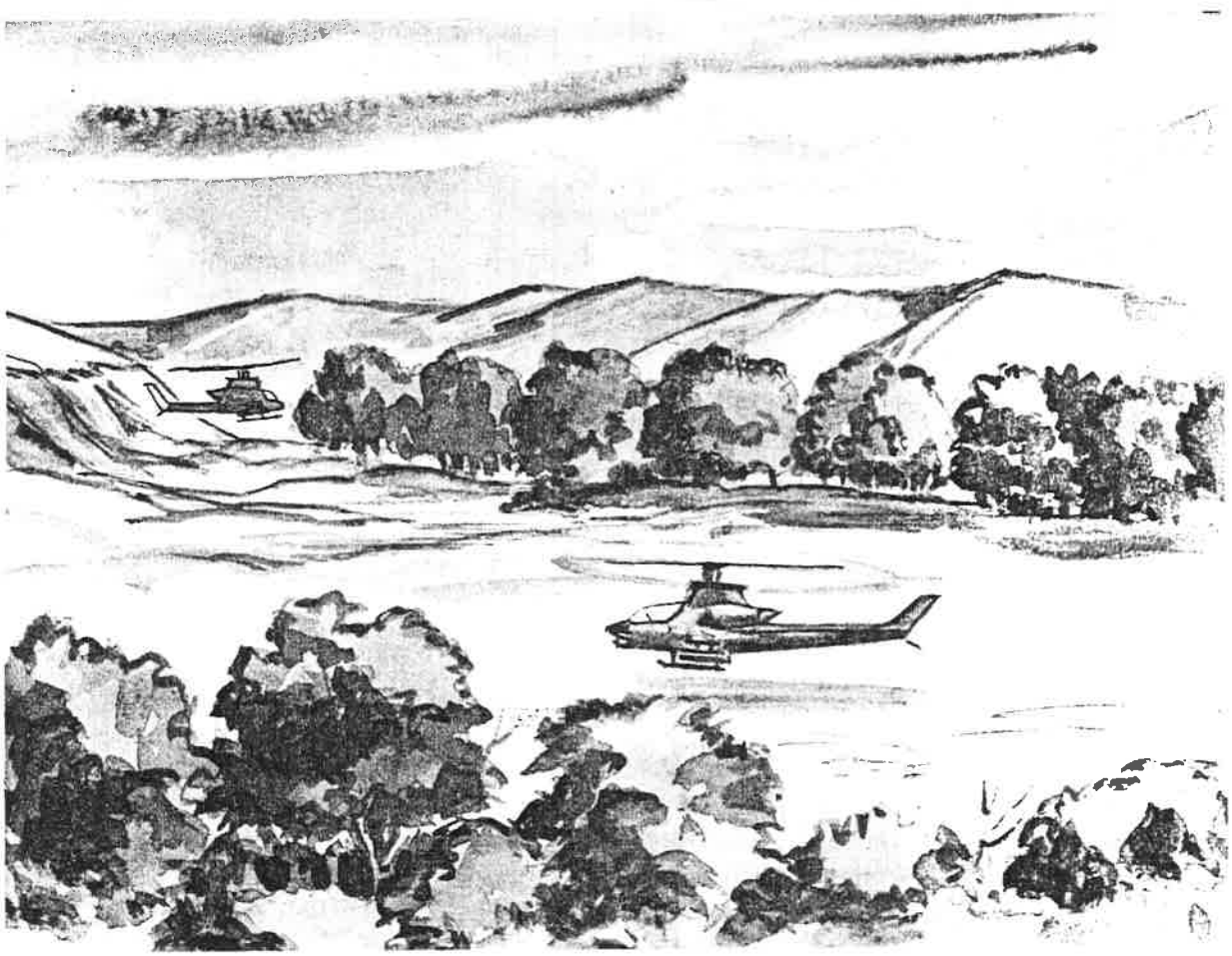
HOLDING AREAS

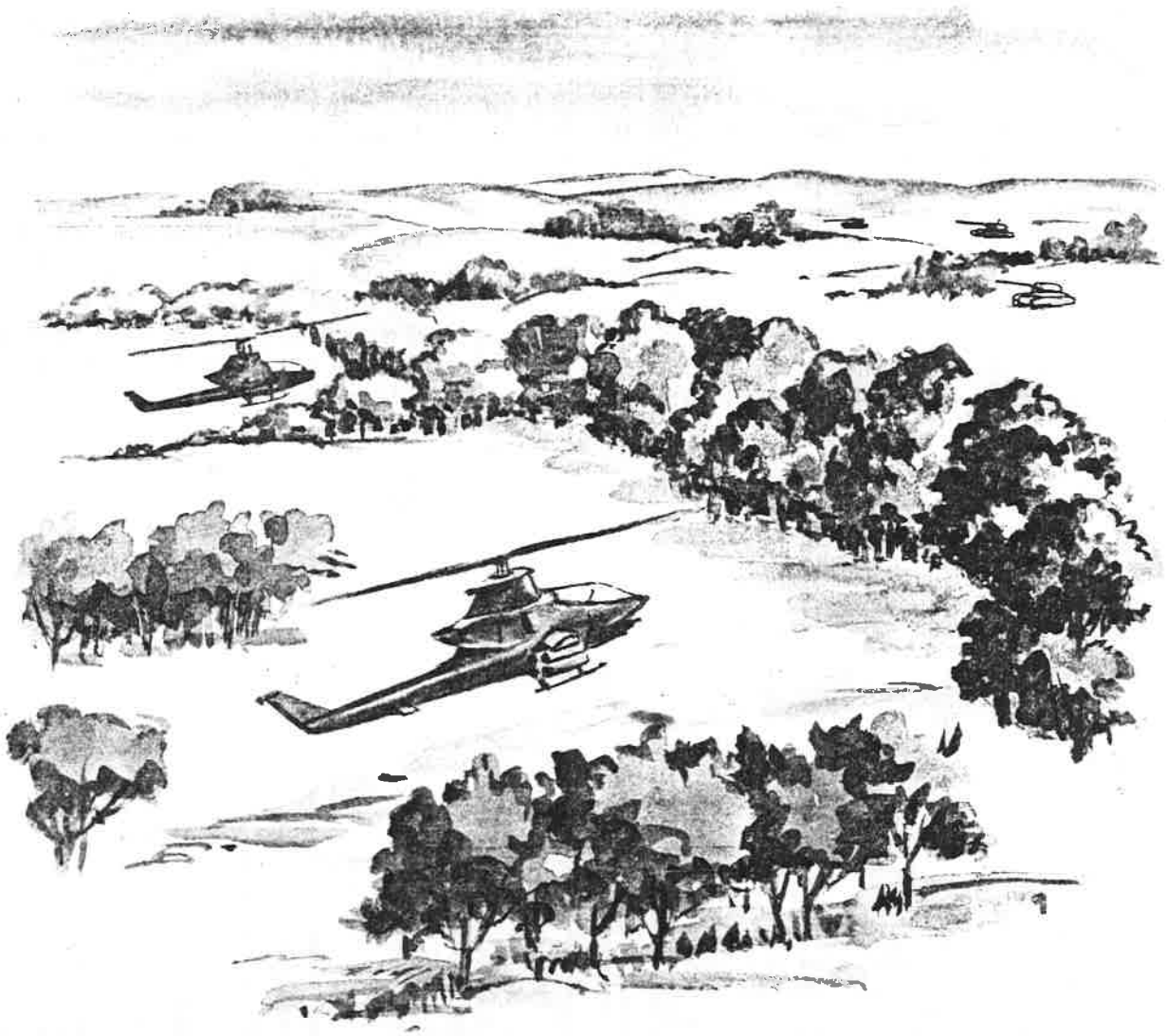
Holding areas are occupied by attack helicopters during the time that aerial scouts are searching for targets. The area should be well forward, but it must provide cover and concealment from enemy observation and antiaircraft fires. It must also be large enough to provide for dispersion if within range of enemy artillery. The holding area should not be on or near a prominent terrain or man-made feature that might be an enemy preplanned artillery target. Ideally, it should also be sufficiently vegetated to provide some protection from aerial observation. These considerations are especially important if helicopters will be shut down in the holding area. Since the holding area is well forward, it may be necessary to supplement its security by inserting a small infantry unit prior to landing the attack helicopters. Also, aerial reconnaissance of the surrounding area may be necessary while occupying the holding area. When the unit's mission is to attack targets of opportunity, the initial coordination between the scout and attack elements is normally made in the holding area. Prior to departing the holding area, each aircrew should know the location of the attack positions, its target sector of fire, and other essential command and control information.



ATTACK ROUTES

The attack route is the corridor used by the unit to move from the holding area to the attack position. An ideal attack route is one which allows the unit to move into the attack position undetected. Normally, a scout will lead the attack helicopters along the attack route at high speed. However, if the terrain relief is such that the helicopters are required to utilize NOE flight, individual helicopters may have to pick their way to the attack position using a map if visual contact with the scout or preceding helicopters cannot be maintained. Detection, even if beyond the range of enemy air defense weapons, eliminates the attack helicopter's advantage of surprise. Therefore, if detection is possible, the smoke and chaff 2.75 FFAR rockets and artillery should be used to mask the unit's movement. The specific considerations relating to route selection as discussed previously generally apply to attack routes.





ATTACK POSITIONS

The attack position is a maneuvering area which contains firing positions, laterally and in depth, for the flight. It is a "transition" area between the attack route and the firing positions. Upon reaching the attack position, final instructions are issued to the flight or final coordination is accomplished with the scout. The attack helicopter crews will then maneuver within the attack position; select firing positions for their individual helicopters; and remain masked, awaiting the order to attack. To prevent their detection and engagement,

the amount of time spent maneuvering within the attack position should be held to a minimum. The process of selecting attack positions begins during premission planning. Aircrews should conduct detailed map reconnaissances of the entire area of operations to identify tentative attack positions and alternates as well as holding areas and attack routes. The suitability of these areas can later be confirmed or modified by aerial reconnaissance as tactical requirements dictate.

During the selection process, emphasis should be placed on cover and concealment. The terrain and vegetation leading to and surrounding the attack position must conceal the attack helicopters from observation by the enemy. For this reason, the map reconnaissance should concentrate on locating attack positions based on:

- Terrain relief
- Access routes
- Availability of alternate positions

During the aerial reconnaissance, the above factors will be confirmed and actual attack positions will be selected after considering:

- Range to the target
- Nature of the target
- The potential effects of rotorwash on surrounding terrain
- Adequate area for proper dispersion between helicopters with multiple firing points
- Obstacles clearance, e.g., wires

Ideal attack positions will provide cover for the attack helicopters to prevent detection by enemy radars and engagement by enemy air defense weapons. They will provide concealment from visual observation. An attack helicopter can be easily detected even though it isn't seen if the enemy can observe unusual movement of the trees, dust clouds, or blowing debris all caused by rotorwash.

For night operations, the enemy's visual acquisition capabilities are greatly reduced. Therefore, the primary consideration is to mask the helicopter from electronic acquisition. When this is not possible, aircrews should keep a terrain feature behind the helicopter. These techniques may either block the helicopter from electronic view or place the helicopter among the ground clutter on the enemy's radar screens.

Attack positions are occupied and vacated on order of the flight leader. Aircrews are allowed freedom of movement within the flight's attack position unless restricted by the flight leader. The flight leader may further reassign attack positions based on the size of the unit. For example, if a company-sized unit is conducting an attack, the flight leader will normally break down the company attack position into platoon attack positions. The platoon leader may further designate section attack position with the platoon attack position.

FIRING POSITIONS

A firing position is a specific point within the attack position which is occupied by a single attack helicopter while actually engaging targets. The selection of a firing position should be based on the following considerations:

➡ *Range.* The firing position should be located so that the kill zone is within the last one-third of the missile range (2,500-3,750 meters).

➡ *Field of fire.* The firing position should permit intervisibility with the target throughout the kill zone.

➡ *Target altitude.* The firing position should be equal to or at a higher elevation than the target area.

➡ *Background.* Terrain features (e.g., vegetation, hill) should be located behind the firing position so that the helicopter will not be silhouetted on the horizon.

➡ *Shadow.* When possible, the firing position should be within an area covered by a shadow.

➡ *Sun.* The firing position should be located so that the sun is positioned behind or to the side of the helicopter.

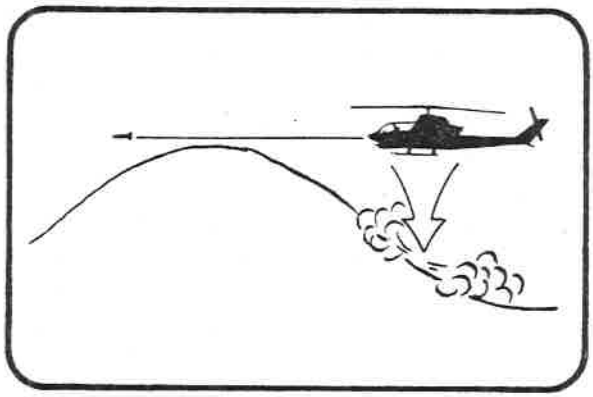
➡ *Rotorwash.* A firing position should be located so that the effect of rotorwash on surrounding terrain (e.g., wires, debris, leaves, snow, dirt) is minimized.

➡ *Adequate maneuver area.* The area surrounding the firing position should permit ease of maneuver to and from the firing position.

➡ *Concealment.* Vegetation surrounding the firing position should facilitate the helicopter being hovered between or beside trees, thus concealing the helicopter from observation.

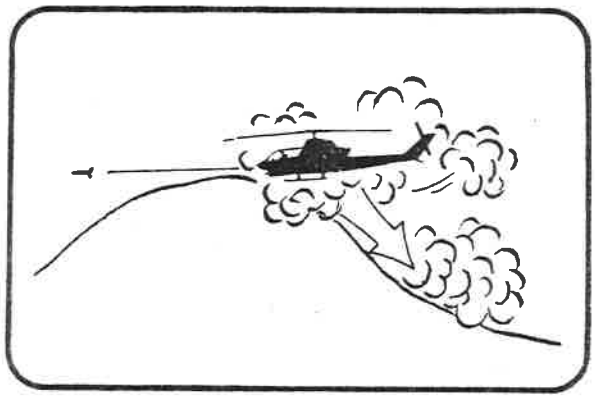
Within the flight's attack position, firing positions may be designated for each helicopter by the flight leader based on recommendations by the scout; or the flight leader may designate sectors of fire for each helicopter

THIS...



WHEN FIRING FROM A STATIONARY HOVER, POSITION THE HELICOPTER SO THAT UNMASKING AND REMASKING IS ACCOMPLISHED BY SIMPLY RAISING OR LOWERING THE AIRCRAFT.

...NOT THIS



BY MOVING FORWARD WHEN UNMASKING DEBRIS, DUST OR SNOW SWIRL UP. THIS SIGNIFICANTLY INCREASES THE SIGNATURE OF THE FIRING POSITION AND YOUR CHANCES OF BEING DETECTED.

and leave final selection of the firing positions up to each aircrew. Alternate firing positions will be tentatively selected by the scout or flight leader for continuing the attack once the attack is in progress.

When the targets close within range (or on order), the attack helicopters will unmask from the firing position, acquire their targets, and begin firing.

Aircrews will engage all targets within their individual sectors with the highest priority being assigned to enemy air defense weapons. Once the attack has begun, targets that are the greatest distance from cover should be engaged first. This procedure will allow the missile to fly to the target before it can reach cover. Firing is conducted from an altitude just above the terrain mask. The attack helicopters will remain in their firing positions and continue to fire until:

- The enemy has been destroyed.
- The ammunition has been expended.
- The firing position becomes untenable.
- The flight leader directs that the attack be terminated or that alternate positions be occupied.
- The flight is relieved on station by a new firing unit.

In the event an aircrew must vacate its firing position and move to an alternate, the aircrew should remask and remain masked until in position to resume the attack. The enemy air defense weapons and supporting artillery will make every effort to fix the location of the attack helicopters and can be expected to return fire in mass and great volume. After the attack has been initiated, the aircrews must be prepared to move to alternate positions and have appropriate routes and coordination measures preplanned.

Upon order to terminate the attack, the attack helicopters will remask and depart the attack position along a preplanned route to an alternate firing position or return to the FARRP.

SUMMARY

There are 13 principles that govern the employment of Army aviation in a high threat environment. They provide a guide for planning and executing tactical operations. Their application must be carefully measured for each situation. More emphasis may be placed on one or more of the principles in any particular situation.

Prior to executing any mission, the aircrew must conduct premission planning. The steps used in planning a mission follow the format of a five-paragraph field order. The amount of planning that can be performed will depend on the type mission. The preplanned mission will normally allow the aircrew sufficient time for detailed planning. Targets of opportunity require that the aircrew react immediately with little time for planning. During the conduct of defensive operations, aircrews are afforded more time for planning. Reconnaissance of attack routes, attack positions, and firing positions can be made without being exposed to enemy observation. During the reconnaissance, intervisibility diagrams can be drawn to insure complete coverage within the kill zone.

The ability of an attack helicopter unit to move about the battlefield undetected will be determined by the route that is flown. Aircrews must learn to use cover and concealment to avoid observation by the enemy. Where terrain features are not available and detection cannot be avoided, the use of suppressive fires, smoke, chaff, jamming, or any other means available which can prevent the enemy from locating or attacking the helicopter, should be used. The method used to move across the battlefield is another factor aircrews must consider. The three methods used are traveling, traveling overwatch, and bounding overwatch.

After receiving a mission, attack helicopter units move from their base of operations to a holding area. This area is occupied during the time the scout searches for a target. It should be located well forward, but it must provide cover and concealment from enemy observation. Upon detection of a target by the scout aircrew, the attack helicopters are called forward. Using preselected attack routes, the helicopter is maneuvered into an attack position. It is a designated area within which the firing positions for the flight are contained. Attack positions are normally selected by a map reconnaissance and confirmed by aerial reconnaissance; however, the scout aircrew may designate attack positions based upon the location of the target area. A firing position is a specific location within the attack position which is occupied by a single attack helicopter. It may be designated by the scout aircrew, or the flight leader, but is normally selected by the individual attack helicopter aircrew. A knowledge of the considerations that are used to select a good firing position is required. The attack helicopter will remain in the firing position and continue to fire until the enemy has been destroyed; all ammunition has been expended; the firing position becomes an untenable position; the flight leader directs that the attack be terminated; or the flight is relieved on station by a new firing unit.

The principles that govern the employment of attack helicopters constitute a collection of commonsense ideas that must be understood in their entirety but are not meant to be rigidly applied. Sound judgment and commonsense are of vital importance to the successful accomplishment of the mission.

CHAPTER SIX

FIRE COORDINATION

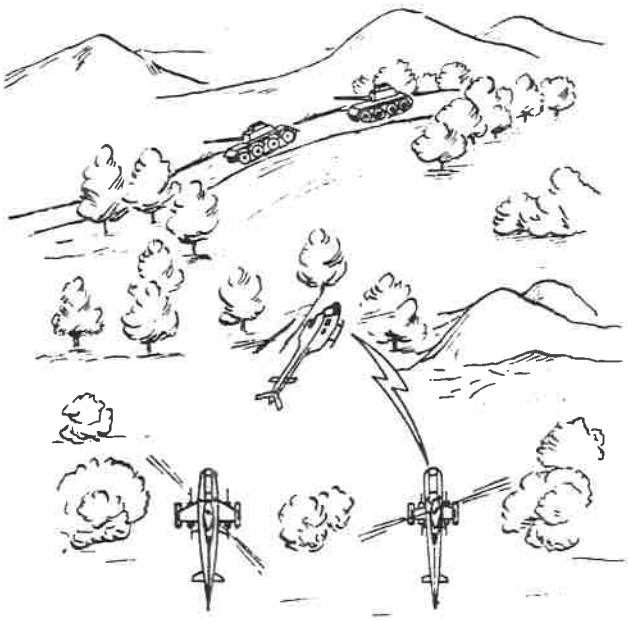
INTRODUCTION

The information presented in this chapter is provided solely as a guide. The specific content or format of a request for fire or a target handoff and fire commands will be dictated by the many variables of the tactical situation. Typically, fire coordination efforts will be "short and to the point." Standard communications channels may have to be modified or, in some cases, improvised. The enemy electronic warfare (EW) threat may preclude standard radio communications, thereby requiring aircrews to supplement their radio procedures with some form of "visual" communications. Therefore, this chapter is more concerned with the what, the who, and the why of attack helicopter fire coordination than the how.

GENERAL

The object of any fire mission, regardless of the weapon used, is to place enough "steel" on the enemy to suppress or destroy him and to do it as quickly as possible. This is a complex and difficult task that requires close coordination among everyone involved. Many people are involved in every fire mission. Targets will normally be acquired by either an airborne or ground observer who will then coordinate the engagement of the target.

Once the attack helicopters are on station, three things must happen before the target can be engaged—



➡A target handoff must be accomplished to the flight leader.

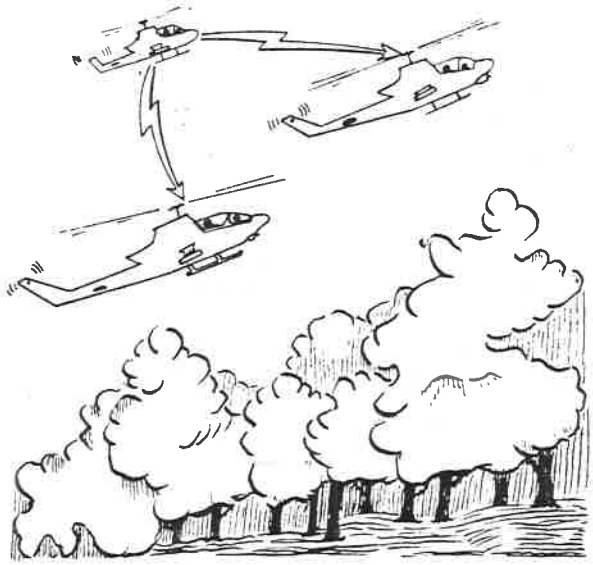
In each fire mission, it is vital that everyone involved know—

Who will do *what.*

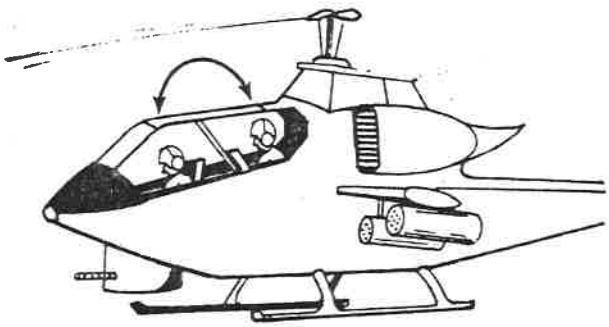
Where and *when* it will be done.

How it will be done and to *whom.*

MISUNDERSTANDING BREEDS FAILURE



➡ The flight leader must issue fire commands to his flight.



➡The crew of each attack helicopter must coordinate its actions.

The attack helicopter is organic to two distinct categories of aviation units: the attack helicopter battalion/air cavalry squadron or separate air cavalry troop and the assault helicopter battalion. The tactical situation, the

unit to fire, and the person who acquires a target will establish which fire support coordination channel will be used.

ATTACK HELICOPTER BATTALION AND AIR CAVALRY SQUADRON TARGET HANDOFF PROCEDURES

The attack helicopter battalion and air cavalry squadron are maneuver units and are employed in much the same manner as their ground counterparts. They are organized to acquire and engage targets without outside assistance. These units will seldom, if ever, be used in a fire-support role and for this reason do not usually answer "calls for fire" from other maneuver units. There is a habitual association between the scout and attack helicopter. The scout aircrew acquires targets (either on its own or from other sources), alerts the attack helicopter, and accomplishes a "target handoff."

The following are the elements, sequence, and explanation of a typical target handoff:

➡*Alert.* The alert identifies the sender and receiver of the message. It warns the receiver that an attack sequence has begun, thus warning him that this transmission is his highest priority.

➡*Acknowledgment.* This element informs the sender that the communications link with the receiver has been completed and that he is ready to receive the message.

➡*Weapon.* The requirement for a specific type of weapon, ammunition, and fuze action is specified in this element. This requirement may be deleted depending on the weapons systems available.

➡*Target Description.* Identity of the target is clearly established. The description should be as brief as possible but must include enough information to present a clear picture of the target. The description should include the type, number, and activity of the target.

➡*Target Location.* The target location may be accomplished by several means, the first of which is grid coordinates. A second method of locating a target is by using the polar plot (direction and distance to the target from the observer or scout) method. The direction to the target may be given by using the clock method, cardinal direction, or compass heading. A final method of target location is by shifting from a known point. The known point may have been prearranged or be a prominent terrain feature or manmade object.

➡*Method of Attack.* The method of attack coordinates all aspects of how the attack will be conducted. It normally includes the mode of flight, type of fire, priority of targets, responsibility for engagement, and actions after the attack.

➡*Method of Control.* This element identifies who will initiate the attack. Two methods of control are used. They are "Attack at my command" and "Attack at will." In addition, the comment "Will adjust" is used for indirect fires.

➡*Acknowledgment.* This is the final element of a target handoff. It is used to insure that all elements have received the instruction, all instructions have been understood, and all elements are prepared to begin the attack.

Following in Table 6-1 is an example of a typical target handoff between the scout and attack helicopter crew. Table 1 also presents the attack helicopter unit and crew fire commands.

TARGET HANDOFF/Fire Command Example

for the Attack Helicopter Battalion and Air Cavalry Squadron

Element	Target Handoff	Team/Section Fire Command	Crew Fire Commands
Alert	Sky Hawk 36 - This is Silver Lion 16 - Attack - Over.	R (See Note I.) Sky Hawk Flight - This is Sky Hawk 36 - Attack - Over.	(See Note 2.)
Acknowledgment	Silver Lion 16 - This is Sky Hawk 36 - Attack.	Sky Hawk 36 - This is Sky Hawk 32 - Attack - Out. Sky Hawk 36 - This is Sky Hawk 33 - Attack - Out. (All aircraft in flight answer in order.)	Pilot or gunner.
Weapon	Missiles and rockets - Flechette and HE.	32 - Missiles - 33 - Rockets, Flechette and HE.	(Not used.)
Target Description	Three tanks on line, moving NE, supported by 40 dismounted infantry.	Three tanks on line, moving NE, supported by dismounted infantry.	Missiles or rockets.
Target Location	Grid 359202 - or from Hill 309, right 1,000, add 2,000.	From firing position 1 - 020° - range 3,500 meters.	Tank moving NE or troops in open.
Method of Attack	Attack from position 1 - Move to attack position 2.	Attack from position 36 and 32 will engage tanks w/ missiles from south end of position 1, running fire with flechette - break right - all aircraft move to position 2.	12 o'clock - 3,500 meters.
Method of Control	Attack at my command or Attack at will.	Attack at my command or Attack at will.	Stationary hover, move to position 2. Running fire, right break, move to position 2.
Acknowledgment	Sky Hawk 36 - Roger, over.	32 - Roger - Over.	Attack at my command or Attack at will.
Execution	Attack - Out.	33 - Roger - Over.	Ready.
		Attack - Out.	Attack.

Notes:

1. R - Required. These elements are normally required to conduct a fully coordinated attack. Other elements are included for special situations or as time permits.

2. Crew fire commands.

a. Supplemental elements may be given after the attack has been initiated. They should be brief and concise.

b. Targets of opportunity are engaged using the briefest possible fire command.

c. When a target of opportunity appears which presents an immediate threat to the crew or flight, the fire command will be prefaced with the warning, DANGER, as an alert, and the command will consist of the information necessary to eliminate the immediate danger. Example: Danger - 32 - break right - ZSU-23 - your 3 o'clock - 1,000 meters.

Table 6-1

ASSAULT HELICOPTER BATTALION TARGET HANDOFF PROCEDURES

The attack helicopters of the assault helicopter battalion (AHB) may accomplish any of the attack helicopter missions as previously described; however, they have the primary mission of aerial escort. When performing escort missions, priority is for suppressive fires to protect and assist the passage of enemy threat areas by lift helicopters; then to the isolation of the objective area; and last to the assault force until it is established and other fire support means are available. While en route, escort helicopters need only suppress or neutralize enemy fire sufficiently to permit the lift helicopter to pass through or around the danger area. They should not become so engaged that proper fire support for the remainder of the escort mission is not available. During escort missions, there is no habitual association between the aircrew and ground or airborne observers. The procedures for calls for fire, target handoffs, and/or adjustments do not apply per se.

However, these attack helicopters will be employed to engage targets of opportunity or to suppress targets that present an immediate threat to themselves or the flight. These targets may be acquired either internally (by members of the flight) or externally (by airborne or ground element). The content of the target handoff and subsequent fire commands will consist only of those elements previously discussed that are required to effect immediate engagement. These elements will normally include identification, target description, and location. A variety of missions for the attack helicopter of the AHB may be conducted in the same time frame and area. For example, immediately following the escort mission, attack helicopters may be assigned specific targets for destruction.

TARGET HANDOFF EXAMPLE

ASSAULT HELICOPTER BATTALION

Identification - "18"

Target Description - "ZSU-23"

Location - "2 o'clock, 2,000 meters"

SITUATION REPORT

After the initial contact has been established between the observer and the attack helicopter flight leader, the observer should provide a situation report. This report includes, but is not limited to, the friendly situation, the intensity of contact (if any), the air defense capability in the target area, and any significant changes in the situation since the initial call for fire was made.

Note. EW considerations, unit SOP, or radio discipline criteria may preclude this report being made.

SITUATION REPORT ELEMENTS

- The friendly situation.
- The intensity of contact.
- The enemy air defense capabilities in the target area.
- Any significant changes in the situation since the initial call for fire was made.

TARGET ENGAGEMENT AND FIRE ADJUSTMENT

The attack helicopters of any of the organizations that have been discussed, armed with the 2.75-inch FFAR, can engage targets using either the direct or indirect mode of delivery.

Direct Fire

When targets are to be engaged using direct fire, the flight leader will announce "Ready to fire" to the observer. At this time, the observer will accomplish a target handoff using the procedures outlined previously. Because of the similarity between the elements of the initial call for fire and a target handoff, an abbreviated format may be used.

Even though the initial call for fire stated that the observer would adjust fire, this will normally become the function of the aircrew when using direct fire. However, the tactical situation may preclude the aircrewmembers from observing. They may be required to remask immediately after firing and/or move to a new firing position. When this occurs, they should request that the observer provide adjustment information in the form of "corrections," e.g., left 100 - add 200. The standard field artillery adjustment procedures followed by fire for effect will not be used. The method of engagement used is a "fire and maneuver" technique whereby the number of rounds expended during each engagement is left to the discretion of the flight leader. Fire for effect, or a variation thereof, may be entered at any time.

Throughout the mission, the observer will provide corrections to the flight leader. If white phosphorous or smoke is being used, the observer may be in a better position to direct their employment and may, therefore, be required to actually adjust these rockets. The fire mission may be terminated by either the flight leader or the observer when one or more of the following conditions exist:

- All armament has been expended.
- The desired effect on the target has been achieved.
- The flight's position/situation becomes untenable because of the enemy air defense posture.
- Allowable fuel has been expended.
- The mission is terminated by the appropriate commander.

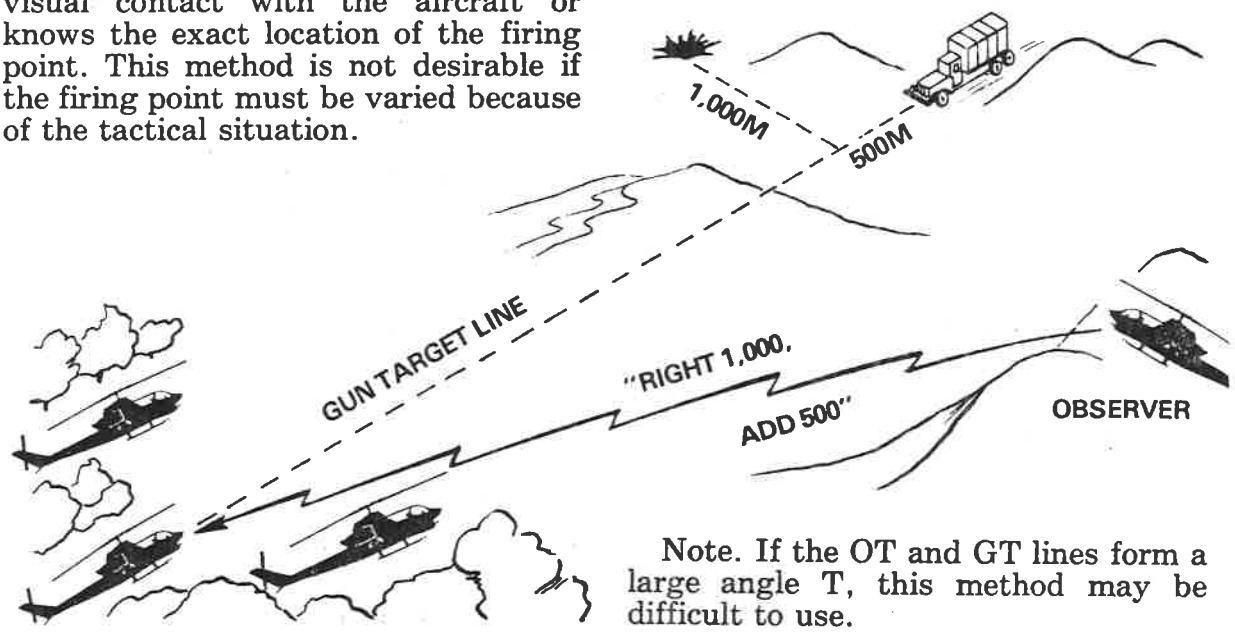
Indirect Fire

Upon completion of the mission, the flight leader and the observer will provide their respective units with a damage assessment and intelligence report.

When targets are to be engaged using indirect fire, the flight leader will announce "Ready and fire" to the observer after reaching the firing position. The observer will begin the fire mission by giving the command of execution - "Fire."

Adjustment procedures for subsequent rounds may be accomplished using corrections in relation to one of three types of reference lines.

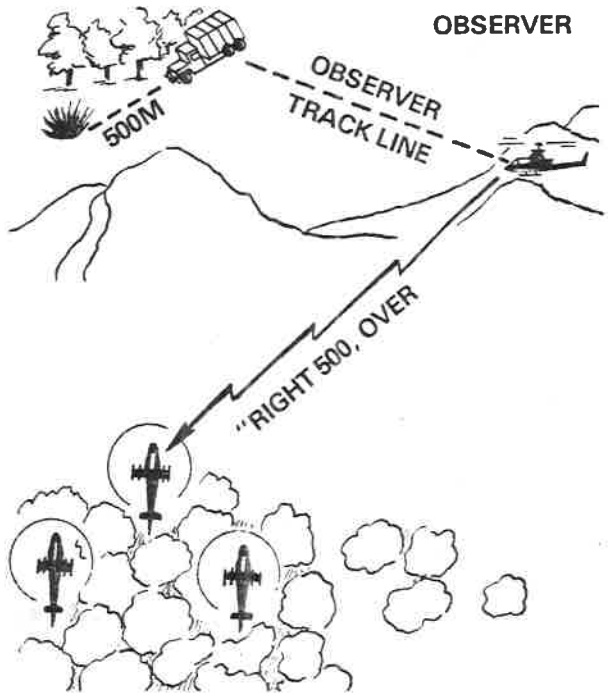
➡*Gun-target (GT) line.* This method may be used when the observer has visual contact with the aircraft or knows the exact location of the firing point. This method is not desirable if the firing point must be varied because of the tactical situation.

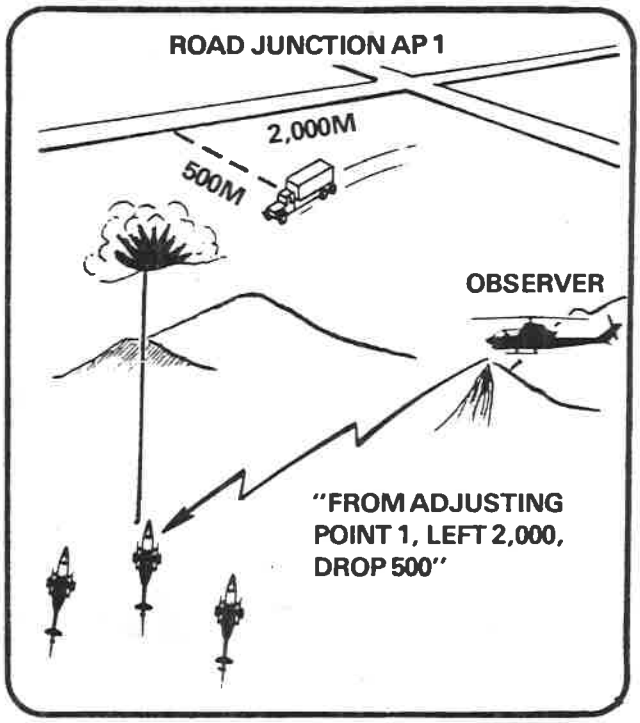


Note. If the OT and GT lines form a large angle T, this method may be difficult to use.

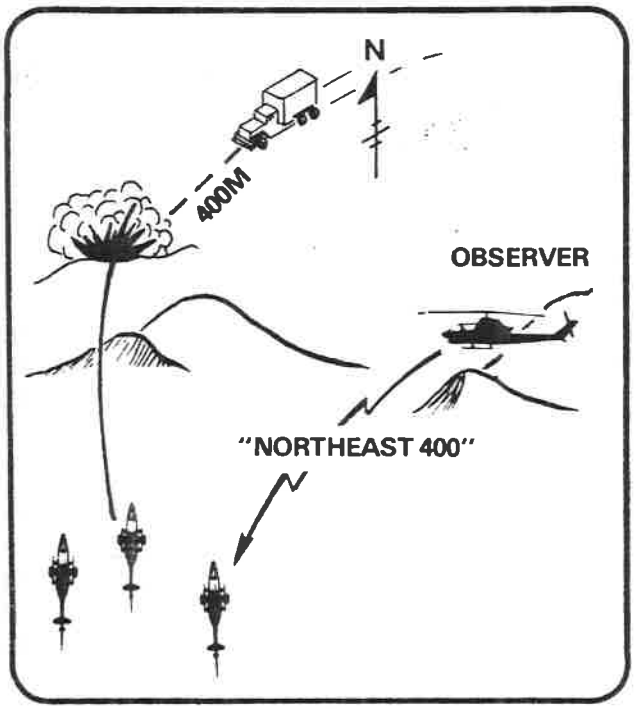
➡*Observer-target (OT) line.* This method requires that the aircrew know either the observer's location or the location of the target and the OT azimuth. The corrections made by the observer must be applied to the gun-target line by the aircrew. This is the least desirable method because it compromises the observer's position to some extent and requires the aircrew to compute corrections. In addition, when the observer is airborne, the reference line may vary.

Note. When using the dead-reckoning computer (chapter 4), it is not necessary for the observer's position to be known. This method then becomes not only the most desirable, it provides the greatest degree of flexibility and accuracy.





➡ *Line of known direction.* The aircrew and observer may choose a readily available reference line such as a stated direction along a road or ridge line in relation to which adjustments can be made. The observer makes distance corrections in relation to a point on the reference line, and these corrections are applied to the gun-target line by the aircrew.



When using North as the line of known direction, shifts can be made from the impact of the last rounds or any other known point, using a distance and direction (e.g., Northwest 330°, 300 meters, or from hill 56° Northwest, 300 meters).

SUMMARY

The object of any fire mission, regardless of the weapon used, is to place enough steel on the target to suppress or destroy it and to do it as quickly as possible. To accomplish this, the elements and sequence of the calls for fire or target handoff and subsequent fire command must be standardized. Also, the unit commander must help to insure that this format is used during training. The specific content or format will be dictated by the many variables of the tactical situation and the type unit performing the mission. There are two distinct categories of aviation units that must coordinate their fires. Attack helicopter battalion/air cavalry units are organized to acquire and engage targets without outside assistance. The scout acquires the target, alerts the attack helicopter, and accomplishes target handoff. The elements of a typical target handoff associated with these type units are:

- Alert
- Acknowledgment
- Weapon
- Target description
- Target location
- Method of attack
- Method of control
- Acknowledgment

The second type unit that must coordinate its fire is the assault helicopter battalion. The attack helicopters of this unit may accomplish any of the assigned missions of aerial escort. Targets are acquired either internally or externally. The content of the target handoff will consist of only those elements previously discussed that are required to effect immediate engagement.

- Identification
- Target description
- Location

The attack helicopter can engage targets using either the direct or indirect mode of delivery. When conducting direct fire, adjustment is normally the function of the aircrew; however, due to the tactical situation, an observer may have to provide adjustment information. The method of engagement used is a fire and maneuver technique whereby the number of rounds expended during each engagement is left to the discretion of the flight leader.

When targets are to be engaged using indirect fire, the flight leader will announce "Ready to fire" to the observer after reaching the firing position. Adjustment procedures for subsequent rounds may be accomplished using corrections in relation to one of three types of reference lines.

- Gun-target line
- Observer-target line
- Line of known direction

To effectively employ the attack helicopter, everyone involved must know and use fire coordination procedures which facilitate immediate engagement of the target.

CHAPTER SEVEN

IMPROVED AMMUNITION AND WEAPONS SYSTEMS

INTRODUCTION

Future conflicts will present a sophisticated enemy in terms of materiel, armor, and air defense weapons. To maximize destruction upon him while minimizing friendly losses, better ammunition and weapons systems are required. This capability is being developed through the improved warheads, remote fuzing, stores management, and fire control system for the 2.75-inch rocket. This chapter discusses the improved capability which can be anticipated for the attack helicopter and the techniques which will be used to effectively employ the equipment and ammunition.

ILLUMINATION WARHEAD (M257)

The US Army's goal is to acquire and maintain a night operation capability that is superior to any potential enemy. To accomplish this goal, combat forces must be able to see the enemy at night. This may be accomplished by using either night vision devices or by providing an artificial light source to illuminate the target area; e.g., flares, infrared light. The primary means of illuminating the battlefield using flares is by field artillery and mortars. A secondary method of dispersing flares is by dropping them from an aircraft overflying the target area. Targets to be illuminated may be located beyond the range of field artillery and over enemy-held terrain. The use of dropped flares subjects the aircraft to a high risk of being destroyed by enemy air defense weapons. To overcome these limitations, the 2.75-inch illumination warhead is being developed. This new warhead gives the attack helicopter aircrew the capability to illuminate the target from a safe distance and from a low altitude, thus reducing exposure to the enemy.

Capabilities and Limitations

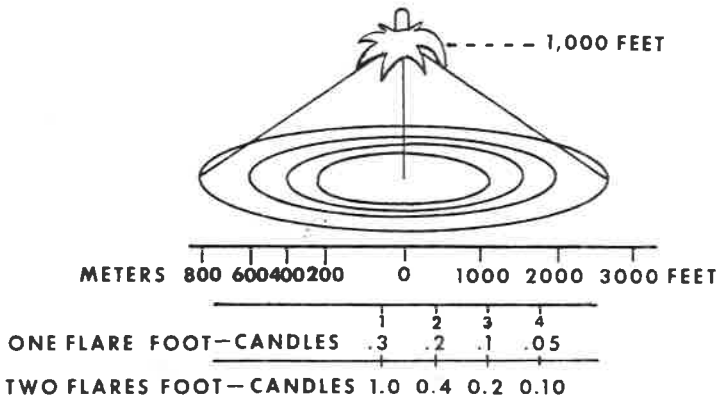
The 2.75-inch illumination warhead (M257) provides in excess of 1 million foot-candles (fc) of illumination for 2 minutes. The range of the present designed warhead is 3,000 meters.

To obtain the maximum effect, based on burn time and rate of descent, the flare should be fired to detonate at an altitude of 1,800 feet AGL. Using the normal rate of descent of 13 feet per second, flare burnout will occur at 300 feet AGL.

Note. An illumination warhead which detonates below an altitude of 1,500 feet AGL will contact the ground before burnout occurs and may cause ground fires.

From an altitude of 1,000 feet AGL, one flare illuminates an area 460 meters in diameter (230 meters from the center) with an illumination intensity of 0.5 foot-candles (25 times the ambient level of a full moon) at the outer edge. The light intensity decreases as the distance from the center increases. At a point 425 meters from the center, the light level decreases to the 0.2 foot-candle level. The illumination finally reaches its minimum usable level of 0.05 foot-candles at a distance of 760 meters from the center.

Note. Visibility restrictions will reduce the light level whereas cloud coverage above the flare rocket will increase the light level over the target area.


1,000 FEET
METERS 800 600400200 0 1000 2000 3000 FEET
1 2 3 4
ONE FLARE FOOT—CANDLES .3 .2 .1 .05
TWO FLARES FOOT—CANDLES 1.0 0.4 0.2 0.10

GROUND ILLUMINATION PATTERN

Two illumination rockets in close proximity to one another will produce 2 million candlepower of illumination or twice the intensity of one flare. Although two rockets double the intensity of the outer illumination boundaries of the ground pattern, they do not double the area of illumination. For example, using one flare, the 0.2 foot-candle level of illumination is reached at 425 meters from the center. With two flares, this point is extended an additional 155 meters or 580 meters from the center. The use of two flares also increases the reliability of flare ignition over the target during an engagement.

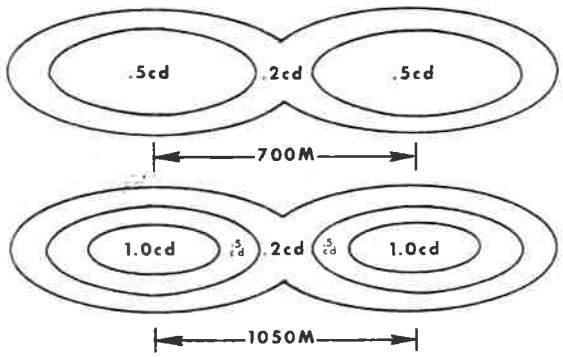
Targets that are larger than what can be illuminated from a single ignition point will require multiple ignition points over the target. These ignition points must be equally spaced over the target area so as to allow a 25-percent overlap of the area illuminated with an intensity of .2 candlepower. As a rule of thumb, when illuminating linear targets requiring multiple ignition points, the spacing between ignition points using one flare should be 700 meters. When two flares are used at a single ignition point, the spacing should be 1,000 meters. Using these rules of thumb, a target can be illuminated 1,500 meters in length with a minimum intensity of .2 candlepower for single flare ignition and 2,200 meters when two flares are used at each ignition point.

Note. During conditions of nonrestricted visibility, a satisfactory light level for identification of a tank silhouette at 2,000 meters requires a light intensity over the target of at least 0.2 foot-candles (0.2 foot-candles is equal to 10 times the ambient light level of a full moon). To identify a prominent terrain feature at 2,000 meters, a light level of 0.05 foot-candles is required (2½ times the ambient light level of a full moon).

To insure continuous illumination over the target, illumination rockets must be fired at 45-second intervals. Using this time interval, the aircrew has sufficient time to fire a second flare rocket before old flare burnout in the event of a flare malfunction.

The spent rocket motor will impact the ground at a distance of from 700 meters to 1,000 meters beyond the target and along the gun-target line of the helicopter firing the illumination rocket. Necessary precautions should be taken when the illumination rocket is fired.

The intensity of the flare rocket after ignition may cause the aircrewmembers firing the illumination rockets to lose their night vision capability when performing the mission with the unaided eye, or a temporary whiteout if night vision devices are used. This condition may be only momentary or as great as 30 minutes with



MULTIPLE POINT ILLUMINATION PATTERN

the unaided eye. To avoid this unsafe condition, one crewmember should turn his head away from the illuminated area. If this cannot be accomplished, view the illuminated area with one eye closed. Night vision is normally restored for crewmembers wearing night vision devices (AN/PVS-5) by turning away from the light source.

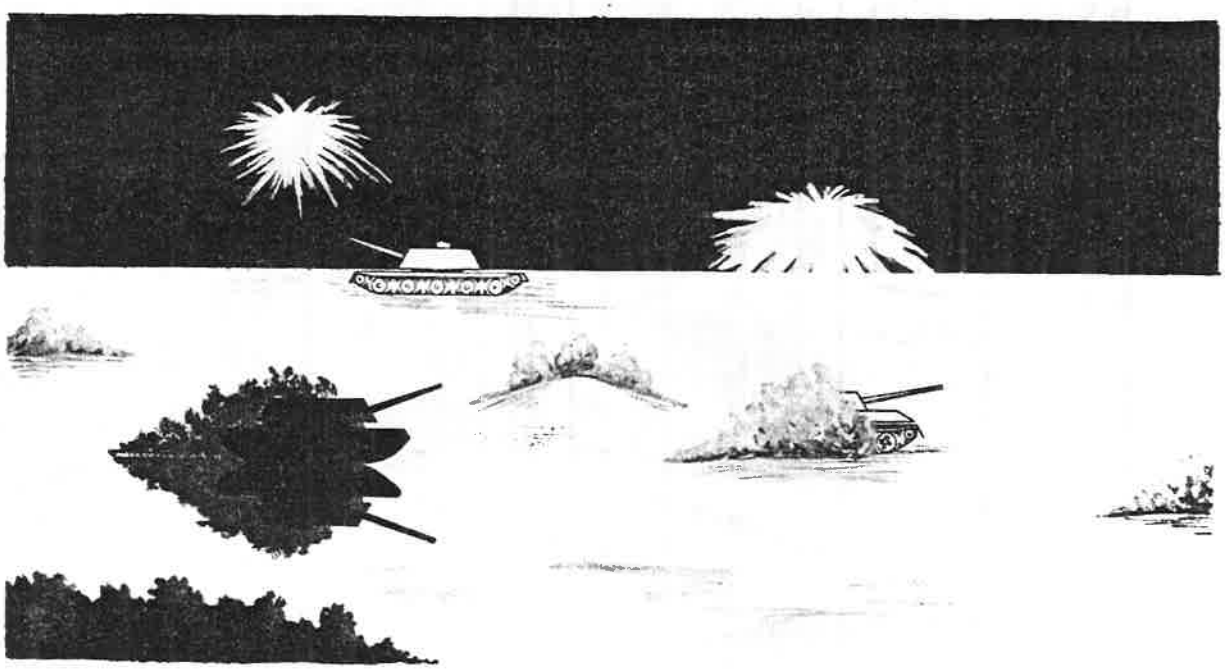
Tactical Considerations

The number of flare rockets that an attack helicopter (AH-1G, AH-1R) will carry is determined by the mission and the helicopter weapons configuration. Unit SOPs should be established designating the payload for each attack helicopter. A single helicopter designated for flare rockets is least desirable because the illumination capability is lost if it is destroyed by hostile fire or experiences maintenance difficulty.

To minimize detection by enemy acquisition devices, the 2.75-inch flare should be fired at terrain flight altitudes. The helicopter firing the flare rocket should be positioned so that the users are between the flare helicopter and the target. When this cannot be achieved, the flare helicopter may fire from the flanks. A firing position between the attacking helicopters and the target should be avoided.

The center of the ground illumination pattern should be positioned behind the target as viewed by the engaging force. This technique enhances target detection by silhouetting the target against the high intensity light as opposed to the dark contrast of the outer illumination boundary.

Although the primary mission of the flare rocket is to provide illumination for combat action, it can be effectively used as a signaling device or as a reference for air navigation. Each mission must be coordinated with the elements that will be affected by the illumination to insure timeliness and accurate location of where the flare rocket will illuminate.



Hover Firing Techniques

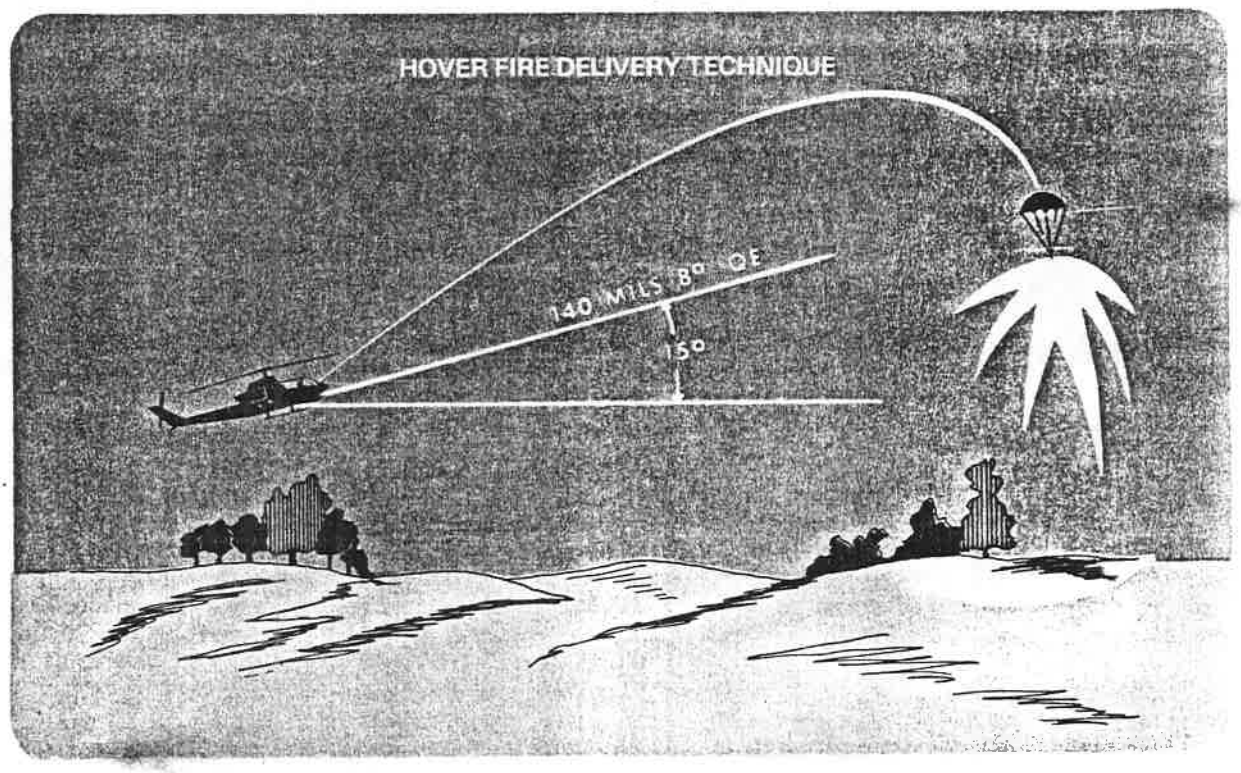
The attack helicopter aircrew can fire the flare rocket using either mode of delivery (direct or indirect). The primary delivery technique used to fire the flare rocket is hover fire. When conditions (e.g., density altitude, load) prevent the use of hover fire, running fire delivery techniques as discussed later should be used.

Hover fire allows the aircrew to continuously illuminate a target requiring multiple ignition points without exposing the helicopter to enemy observation and a greater degree of accuracy. Additionally, this delivery technique reduces the maneuver requirements that are required when conducting running fire. The hover fire delivery technique has the disadvantage in that rearward flight occurs when pitching the nose up to the firing attitude. Because rearward flight occurs, greater clearance should be available both below and behind the helicopter.

When firing the flare rocket, the aircrew should fire from selected firing points on the ground. This procedure permits accurate range determination and provides a reference point for range adjustment.

When time permits, a map reconnaissance should be conducted and several points selected that provide recognizable terrain features. Upon arriving in the mission area, final selection of primary and alternate positions is made. If the target area cannot be seen from the firing position, the direction to the target must be measured from the map.

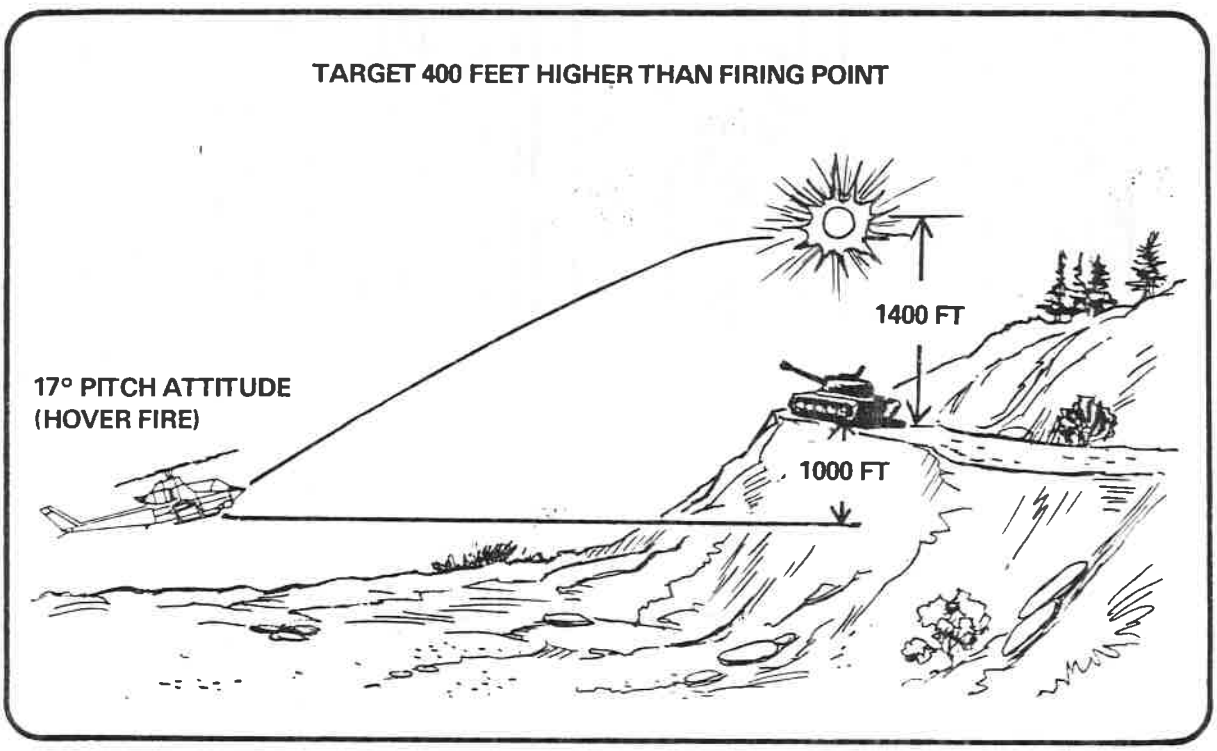
To achieve the desired flare ignition height using a launcher quadrant elevation of 140 mils, a 15° nose-high attitude is required. To obtain the proper firing attitude, the pilot must



first determine the horizontal reference for the helicopter. The first requirement is to position the helicopter on level ground and then adjust the horizon bar so that level flight is indicated. When the helicopter is flown to a hover, the horizon bar will be displaced above the miniature aircraft indicating a nose-low attitude. The position of the horizon bar above the miniature aircraft is the horizontal reference. This reference will vary from one helicopter to another depending on the turret configuration and the weight of the aircrew. The pilot may elect to fly the helicopter during the mission without adjusting the attitude indicator or he may mentally note the position of the horizon bar and adjust it for level flight. If the horizon bar is adjusted for level flight, prior to firing a flare rocket, it must be adjusted to the horizontal reference position.

Example: Assume the hover attitude of the helicopter is 5° nose-low. This condition will result in the horizon bar being displaced 5° above the miniature aircraft. To obtain the proper firing attitude, the pilot must first raise the nose of the helicopter until the horizon bar is level with the miniature aircraft. From this position, he pitches the nose up 15° and fires. Both requirements are conducted as a continuous maneuver. The horizon bar will be displaced 20° below the miniature aircraft when the helicopter is on the proper firing attitude. Using this procedure, the aircrew is provided a constant horizontal reference regardless of the load or configuration of the helicopter.

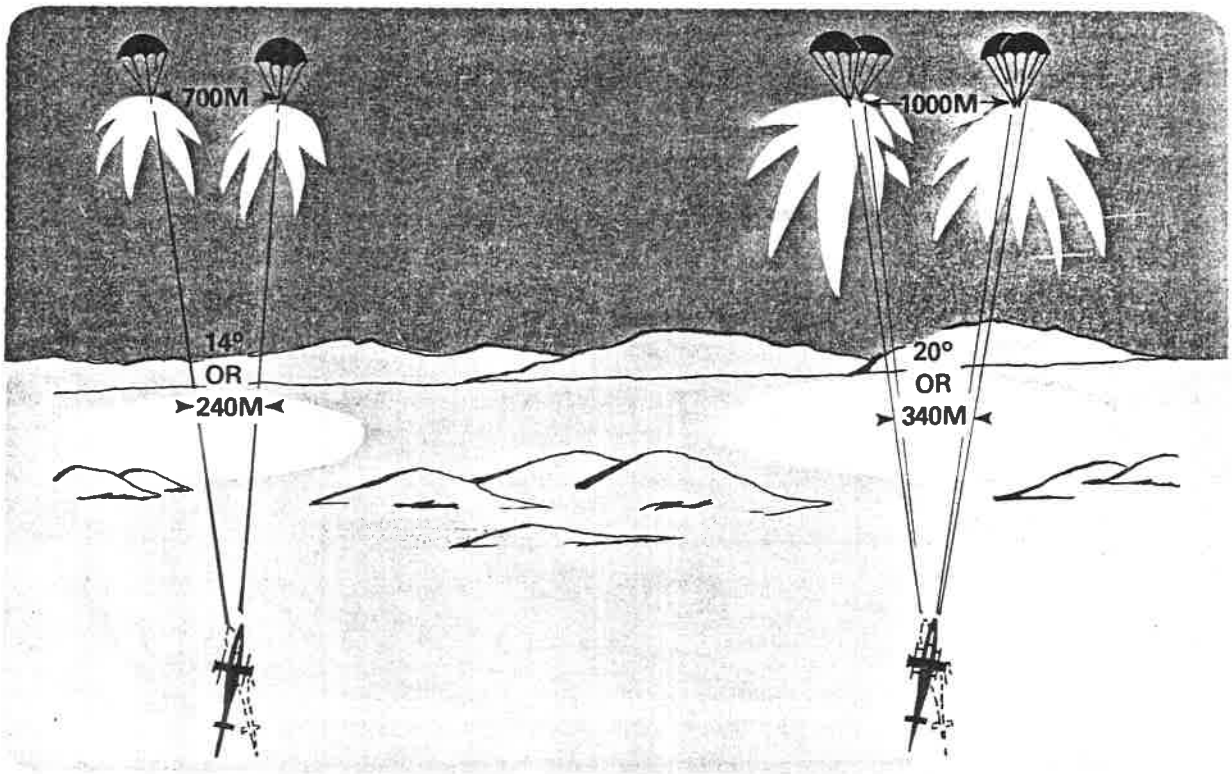
If a higher or lower height of flare ignition is required due to differences in the terrain altitude between the firing position and target area, the firing attitude should be increased or decreased 1° for each 200-foot difference in elevation. For example, the standard 15° attitude for hover fire should be increased to 17° if the target is 400 feet above the firing point.



If the target area can be seen, the pilot can adjust for lateral corrections, using the last flare fired as a visual reference. By viewing the flare through the M73 gunsight, accurate adjustments can be made. Displacement of the reticle image (pipper) 10 mils right or left of the aiming point will move the ignition point 30 meters laterally. When the target area cannot be seen, the pilot must adjust the heading by reference to the heading indicator. A 1° change in heading will move the ignition point approximately 50 meters laterally.

Range corrections required to cause flare ignition over the target area are made by moving the firing point closer or farther from the target area. Corrections in range should not be made by changing the pitch attitude. Although a small change in horizontal distance will occur when the pitch attitude is increased or decreased, the primary effect will be a change in flare ignition altitude.

When required to maintain continuous illumination over a target area, the aircrew must first determine the number of ignition points that are required to illuminate the target area. Using the rule of thumb for spacing between ignition points, a heading change of approximately 14° or 240 mils is required between firings when using one flare at each ignition point. If two flare rockets are used at each ignition point, a heading change of approximately 20° or 340 mils is required to achieve the desired spacing. After the first flare rocket has been fired, the pilot turns the helicopter to the proper heading while maintaining the same firing position, and fires. Heading changes are not required when illuminating targets that require one ignition point. To maintain continuous illumination of the target area, a 45-second time interval between firing is required.



Running Fire Techniques

A second delivery technique used for firing the flare rocket is running fire. This technique has the advantage that less power is required and the helicopter is more stable when firing. It has the disadvantage that to maintain continuance illumination, the helicopter must be maneuvered at low altitudes while executing steep turns. Also, it is difficult to overfly the same firing point at night thus reducing the accuracy that can be achieved.

The selection of a firing point and direction of fire is the same as discussed under hover fire. Once the firing point has been selected, the pilot must determine the pattern that will be flown. The rate of turn and the time of the outbound leg are determined by the time interval between firing and the number of helicopters available to fire. A single helicopter illuminating a target with one ignition point must fly a circular pattern to maintain an interval between firings of 45 seconds. The rate of turn will be greater than a standard rate turn. If two helicopters are available, a racetrack pattern can be flown. To maintain the desired time interval between firing, the helicopters should be positioned 45 seconds apart within the pattern. A target requiring multiple ignition points cannot be illuminated with one helicopter using running fire. When multiple ignition points are required, each helicopter should establish separate firing points.

To achieve the desired height of burst, a 20° pitchup attitude is required. This attitude is based on a launcher quadrant elevation of 140 mils and an airspeed of 60 knots.

The procedures required to determine the proper firing attitude and corrections for lateral and range error are the same as discussed for hover fire.

SMOKE WARHEAD

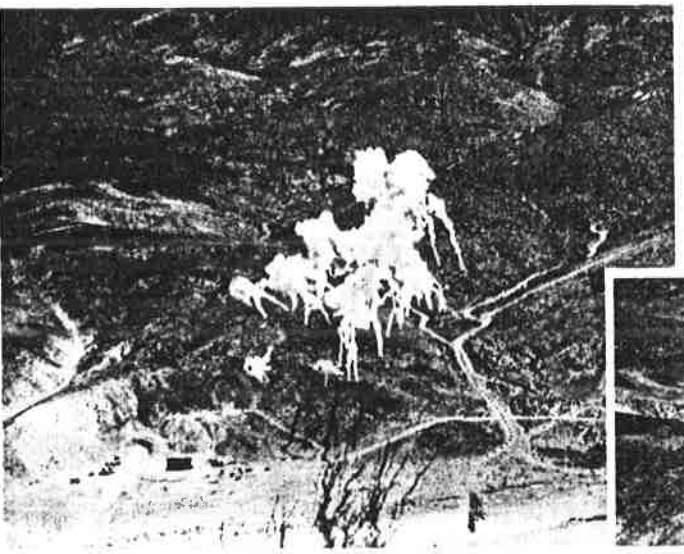
In future conflicts, the enemy is expected to have significant quantities of radar and infrared target acquisition systems. If these sophisticated acquisition systems are not operable or are rendered ineffective by countermeasure devices, optical tracking can be expected to be the primary mode of operation. In addition to the nonportable sophisticated systems, the foot soldier with his highly destructive weapons must be countered. The tactical use of smoke, as a screen, is a direct means of establishing protection from visual acquisition. Present methods of delivering smoke utilize field artillery, flyover aircraft, and a standoff capability provided by the 2.75-inch rocket white phosphorous (WP) warhead. The use of field artillery is limited by range and availability. Overflight of the target subjects the aircraft to hostile fire. The use of the WP rocket warhead is limited by the minimal screening ability of white phosphorus which pillars and has little duration. The proposed smoke warhead will provide a controlled burning rate for the white phosphorous with longer endurance.

Capabilities and Limitations

The smoke rocket will provide the attack helicopter aircrew the capability to deliver tactical smoke screens from various standoff ranges. A variable fuze setting which will give the aircrew the capability to select different ranges is not currently available with the experimental warhead. Testing is being conducted to determine the tactical ranges required to effectively employ the smoke rocket.

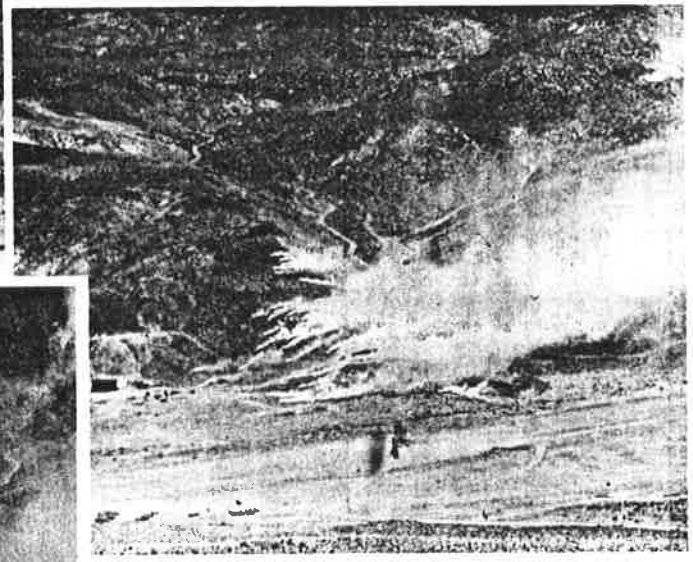
The optimum burst height is estimated to be about 150 to 200 feet above the ground; however, testing is being conducted to verify this. No significant loss of smoke occurs in the few seconds

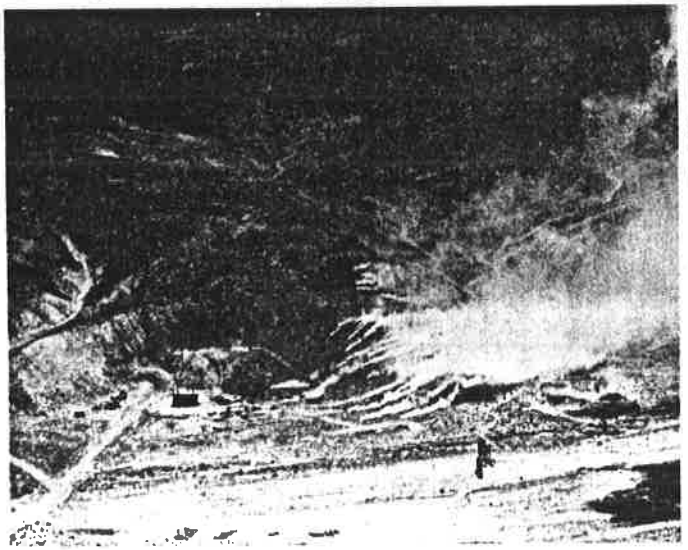
Foldout



Left: Warhead initiation - 19 rockets fired at target 300 meters in length.

Below: 2 minutes and 45 seconds after warhead initiation, target is obscured.





Left: Four minutes after warhead initiation, smoke is beginning to dissipate. Replenishment is required to maintain continuous screening.

required for the wicks to fall to the ground following warhead functioning.

The smoke pattern on the ground is dependent upon air density, the wind velocity, and the atmospheric cooling condition.

➡ With all other conditions being equal, smoke dispersed during high pressure conditions tends to remain closer to the ground contained in a cloud-like formation, whereas, low pressure conditions will cause the smoke to rise and dissipate more rapidly.

➡ The greatest effect on the use of smoke is wind velocity. No matter what the condition of the atmosphere, wind will cause the smoke to dissipate, thus reducing the effect of the smoke on the target area. Dispersing of smoke when wind exists will require more smoke warheads to achieve the desired screening effect.

➡ Atmospheric conditions, which cause the rising air to cool faster (lapse) than normal (neutral) or when an inversion exists (temperature increases as altitude increases), will affect the smoke dispersion pattern on the target. A high lapse rate will cause warm air to rise faster, causing the smoke pattern to dissipate more rapidly. The best effect from smoke during a high lapse condition is achieved during the first few minutes after warhead detonation. The optimum condition for dispersing smoke is when an inversion exists. During this condition, there is little lifting action, thus causing the smoke to concentrate near the ground.

The burn time of the smoke wicks is approximately 5 minutes. Maximum effectiveness is obtained approximately 2 minutes after warhead initiation followed by a gradual decrease in intensity.

Tactical Considerations

Missions for which the smoke rocket can be effectively employed are:

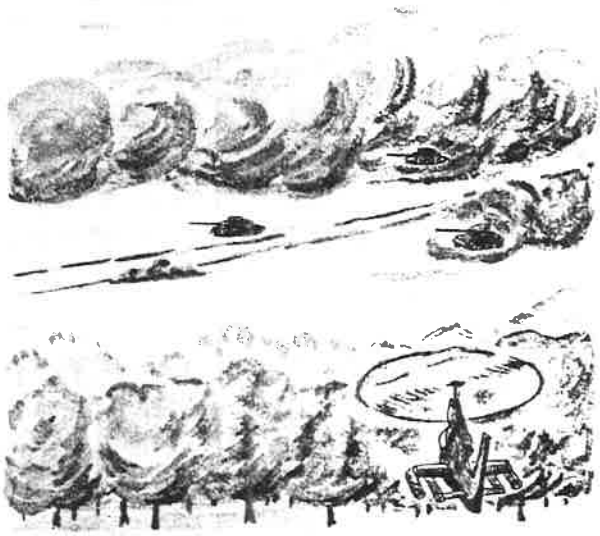
The smoke rocket can be used to place a screen on selected targets within an array of targets being engaged by an attack helicopter element. This tactic enables the aircrews to engage the most critical targets while others are momentarily screened, thus disrupting the enemy's overall capability to visually acquire and engage the attacking helicopters.

During offensive and defensive operations by friendly maneuver forces, smoke screens can be used to deny the enemy visual observation of tactical movements. The capability to provide rapid dissemination of smoke to take advantage of terrain features and the vulnerability of the enemy provides the force commander an additional element of combat power not realized in previous conflicts.

The use of smoke to screen special operations (e.g., river crossings, rescue operations, resupply) provides the force conducting the operation protection from observation by the enemy and reduces his ability to place effective fire on the friendly force.

During air assault operations, smoke screens can be laid down by attack helicopters which will screen the assault helicopters without overflying the target area. This capability increases the survivability of the assault helicopters by denying the enemy the capability to place effective observed fire during the landing.

The smoke rocket can be used to mark targets as a signaling device and to provide navigational reference points along a flight corridor. The use of the smoke rocket is limited only by the imaginative and innovative ideas of the aircrew employing it.



THE PROPER USE OF SMOKE REDUCES THE ENEMY'S ABILITY TO REACT TO ATTACK

When employing the smoke rocket, consideration must be given as to how it will affect the friendly forces. Where favorable wind conditions do not exist, a tactical advantage may not be achieved by employing it. An example of this condition would be during an assault. Wind conditions may cause the smoke to drift across the landing zone, causing a dangerous condition for landing helicopters.

Firing Techniques

Although new delivery techniques are being developed, certain basic fundamentals for the 2.75-inch FFAR apply to the 2.75-inch smoke rocket. The following delivery techniques should be used when firing the smoke rocket.

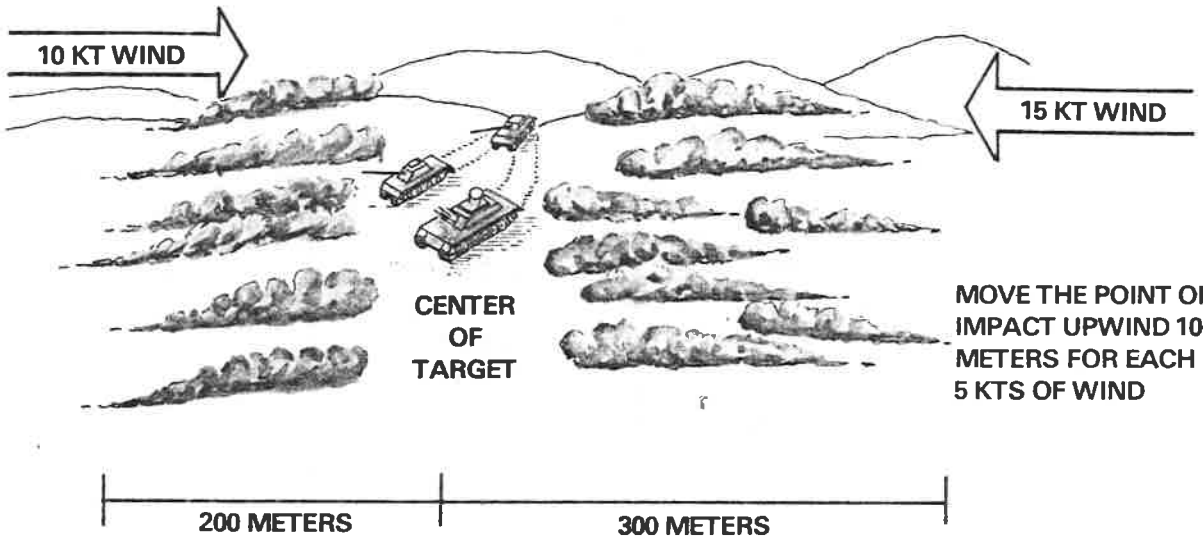
➡The smoke rocket can be launched using direct and indirect firing techniques while at a hover or during running fire. Running fire is the most accurate delivery technique.

➡The weight of the warhead (8.5 pounds) is less than the standard 10-pound warhead used in developing the sight card discussed previously. The mil settings contained in gunnery tables for the 2.75-inch FFAR will cause smoke rockets to travel a greater horizontal distance. Gunsight and fuze settings which will cause the smoke rocket to deploy 150 to 200 feet above the target for a given range are being developed.

➡The desired impact point is seldom on the target itself. Before firing the first smoke rocket, the aircrew must estimate the approximate wind velocity and direction. As a rule of thumb, the point of impact should be moved upwind 100 meters from the center of the target for each 5 knots of wind.

➡To achieve optimum results, a large volume of fire in a short period of time is required. This can be achieved with the greatest degree of accuracy in the shortest period of time by two helicopters firing simultaneously at the maximum rate of fire. Because the firing attitude cannot be maintained long enough to fire accurately sufficient number of rockets, successive engagements may be required when only one helicopter is used.

➡To insure continuous coverage of the target area, replenishment fires are made at approximately 4-minute intervals. This procedure is based on an average atmospheric condition. The existing meteorological conditions which limit the effectiveness of smoke as discussed previously, must be evaluated to determine the frequency of replenishment. In addition, the dispersion of the rocket will reduce the volume of smoke that can be concentrated over the target and will require more smoke rockets to achieve the desired effect. This factor will be less critical when variable time fuzes are developed for the warhead.


10 KT WIND
15 KT WIND
CENTER OF TARGET
MOVE THE POINT OF IMPACT UPWIND 100 METERS FOR EACH 5 KTS OF WIND
200 METERS
300 METERS

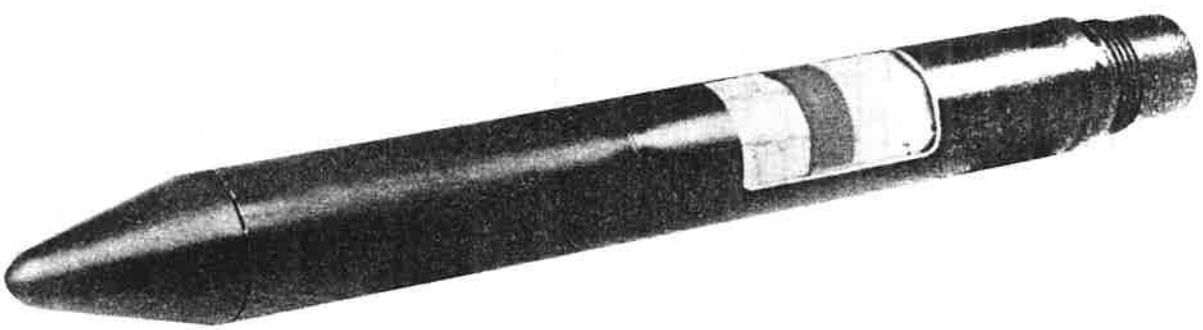
ROCKET EXPENDITURES FOR SMOKE SCREENS

Under Cross Wind Conditions (Normal to Line-of-Sight)
Firing Unit: One Helicopter with Two 19-Rocket Pods

Screen Length (Meters)	Number Rockets to Establish/to Maintain Screen Under Indicated Weather Conditions				
	Lapse/5 knots	**Neutral/5 knots**	**Neutral/10 knots**	**Neutral/15 knots**	**Inversion/5 knots**
200	*8 Rkts* (8 Rkts per 4 min up to 15 min)*	*4 Rkts* (2 Rkts per 4 min up to 70 min)*	*4 Rkts* (4 Rkts per 4 min up to 30 min)*	*4 Rkts* (4 Rkts per 4 min up to 30 min)*	*2 Rkts* (2 Rkts per 4 min up to 70 min)*
400	*14 Rkts* (14 Rkts per 4 min up to 10 min)*	*8 Rkts* 4 Rkts per 4 min up to 30 min)*	*8 Rkts* (8 Rkts per 4 min up to 15 min)*	*8 Rkts* (8 Rkts per 4 min up to 15 min)*	*4 Rkts* (2 Rkts per 4 min up to 70 min)*
600	*20 Rkts* (18 Rkts at 4 min)*	*10 Rkts* (6 Rkts per 4 min up to 20 min)*	*10 Rkts* (10 Rkts per 4 min *up to 10 min)**	*12 Rkts* (12 Rkts per 4 min up to 10 min)*	*6 Rkts* (2 Rkts per 4 min up to 70 min)*
800	*26 Rkts***	*14 Rkts* (8 Rkts per 4 min up to 10 min)*	*16 Rkts* (16 Rkts at 4 min)*	*18 Rkts* (18 Rkts at 4 min)*	*8 Rkts* (2 Rkts per 4 min up to 60 min)*
1000	*32 Rkts***	*18 Rkts* (10 Rkts per 4 min up to 10 min)*	*20 Rkts* (18 Rkts at 4 min)*	*22 Rkts***	*10 Rkts* (4 Rkts per 4 min up to 30 min)*

*Helicopter load of 38 rockets expended at the approximate total time indicated.

**Insufficient number of rockets available to conduct maintenance fire.



CHAFF WARHEAD

The enemy's doctrine for mid-intensity warfare emphasizes swift movement, spearheaded by a massive armor attack embedded with infantry and antiaircraft weapons. As this force advances, an umbrella of air defense protection is provided by medium-range and long-range missiles. To effectively counter this force, a means is needed to counter the enemy's electronic acquisition and fire control weapons. The proposed chaff warhead will provide the needed protection for helicopter aircrews to prevent or degrade acquisition by enemy radar.

Capabilities and Limitations

The proposed chaff rocket will provide the attack helicopter aircrew the capability to deliver a cloud of reflective metallic fibers of sufficient density to adversely affect enemy radar equipment. A variable fuze setting which will give the aircrew the capability to select different ranges is not currently available with the experimental warhead. Testing is being conducted to determine the tactical ranges required to effectively employ the chaff warhead.

To achieve protection by use of the chaff rocket, the helicopter must be in close proximity behind, below, beside, above, or within the chaff cloud. Testing is being conducted to determine the distances the helicopter may be from the chaff cloud and still achieve electronic screening. It is not anticipated that the screening capability of the chaff cloud will be significantly reduced when a flight of helicopters is flown through the cloud.

Visual detection of the chaff cloud is difficult if not impossible. Visual detection means such as color smoke is being tested as a method of marking the point where the warhead functioning occurred.

Atmospheric conditions, e.g., wind velocity, stability, will determine how long the chaff cloud will maintain sufficient density to defeat the enemy radar acquisition capability. Under average conditions, the chaff fibers will fall at a rate of 1 foot per second. To insure continuous screening, replenishment must be planned to account for nonstandard atmospheric conditions and the normal fall rate.

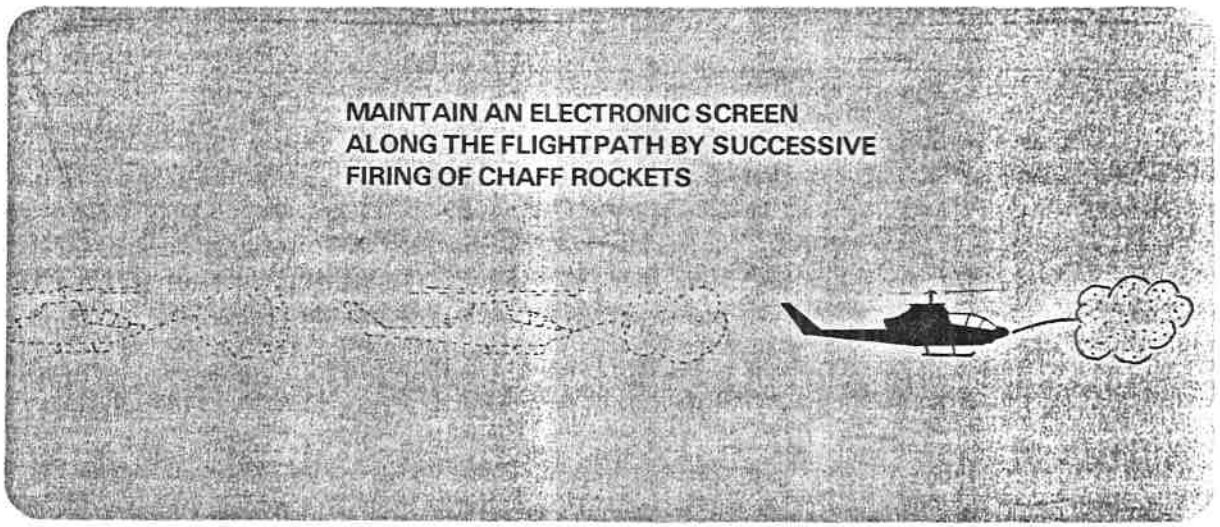
No measurable maintenance deficiencies have been experienced by test helicopters which have flown through or hovered in a chaff cloud.

The number of chaff rockets required to provide lateral screening for a flight of helicopters is determined by the number of helicopters, the lateral limits of the formation, and the length of the flightpath. The area of protection afforded by one chaff warhead is not available. Further testing is being conducted to determine this information.

Tactical Considerations

The chaff round is used as a secondary countermeasure to terrain flying in order to defeat the enemy's radar acquisition capability. When little or no protection from terrain features is available, the chaff rocket is fired to provide electronic screening from the enemy radar or to cause the radar to break lock. When flying over this type of terrain in areas where known enemy electronic fire control weapons exist, the chaff rocket can be fired in front of the helicopter as it proceeds along the flight route. This technique provides continuous electronic screening as the helicopter passes through a high threat area.

Upon detection of enemy radar track, several chaff rockets should be fired by the overwatch aircrew in the general area of flight. Electronic screening may not be achieved due to the position of the radar in relation to the direction of flight; however, the chaff clouds may cause the radar to break lock on its initial target. This procedure should be followed by a formation breakup and an attempt to obtain terrain masking.



To minimize the air defense threat against attack helicopters engaging armor targets, multiple chaff clouds may be delivered by attack helicopters in front of the attacking helicopters. This tactic provides an electronic screen between the attacking helicopters and electronically controlled air defense weapons, thus reducing their capability to electronically acquire a target. In conjunction with this tactic, smoke should be used to obscure visual acquisition.

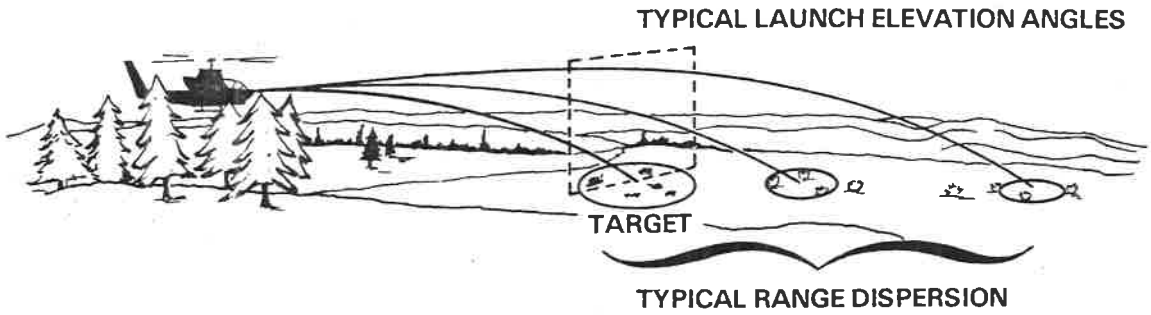
The radar return from a chaff cloud can be identified by a trained radar operator and engaged by threat weapons. To confuse the enemy as to which chaff cloud the helicopter is concealed in, it may be desirable to fire numerous rockets and establish more than one chaff cloud.

Attack helicopters equipped with the stores management system are capable of carrying chaff rockets as part of their payload and selecting this warhead when the need arises. The unit SOP should establish the number of chaff rockets to be carried and the criteria for their deployment. If the attack helicopter is not equipped with a stores management system, one or more helicopters within the flight may be designated to carry sufficient chaff rockets to provide protection for the entire element.

Firing Techniques

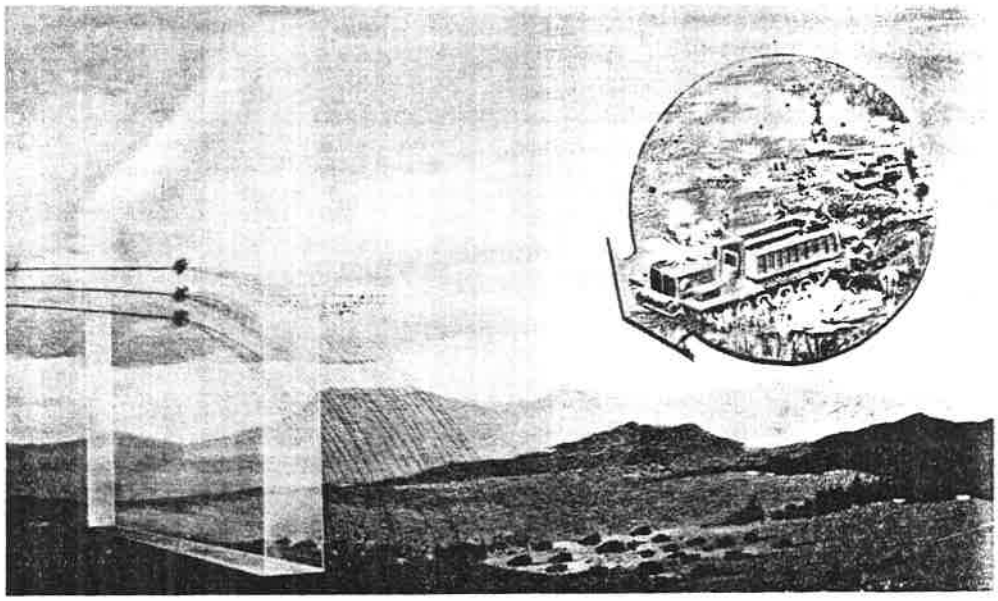
To effectively employ the chaff rocket, the aircrew of the attack helicopter must have an understanding of the employment concept and be proficient in the delivery techniques. Unlike other 2.75-inch rockets, the range at which the chaff rocket will most often be used is relatively close (less than 2,000 meters). Specific firing techniques are being developed and will be published when information is available.

FUTURE SYSTEM IMPROVEMENTS



Submunition Warhead

Because the dispersion pattern is long and narrow when firing the 2.75-inch FFAR from NOE altitudes, maximum effect on the target cannot be achieved. To minimize the dispersion pattern, the submunition concept for firing rockets has been developed. This principle incorporates a high drag warhead equipped with a variable time fuze which can be remotely set from the cockpit to function at a precise time in order to broadcast the submunition over the target area. This principle of employment virtually lifts the target area 90° from the horizontal, presenting it as a vertical wall-in-space. The high drag submunition concept is similar to hitting a wall with eggs. If eggs are thrown at a wall, each egg will splatter and trickle straight down to the ground. Whether the egg hits the wall at 10 feet or 100 feet, it will follow a vertical descent to the ground. Similarly, a rocket with a submunition warhead can be set to detonate at a desired range which will cause the bomblets to fall in a nearly vertical direction. Any number of rockets can be fired with the same time setting, resulting in the bomblets falling over the same area. Each warhead will contain a payload of multipurpose submunitions.



Fire Control System

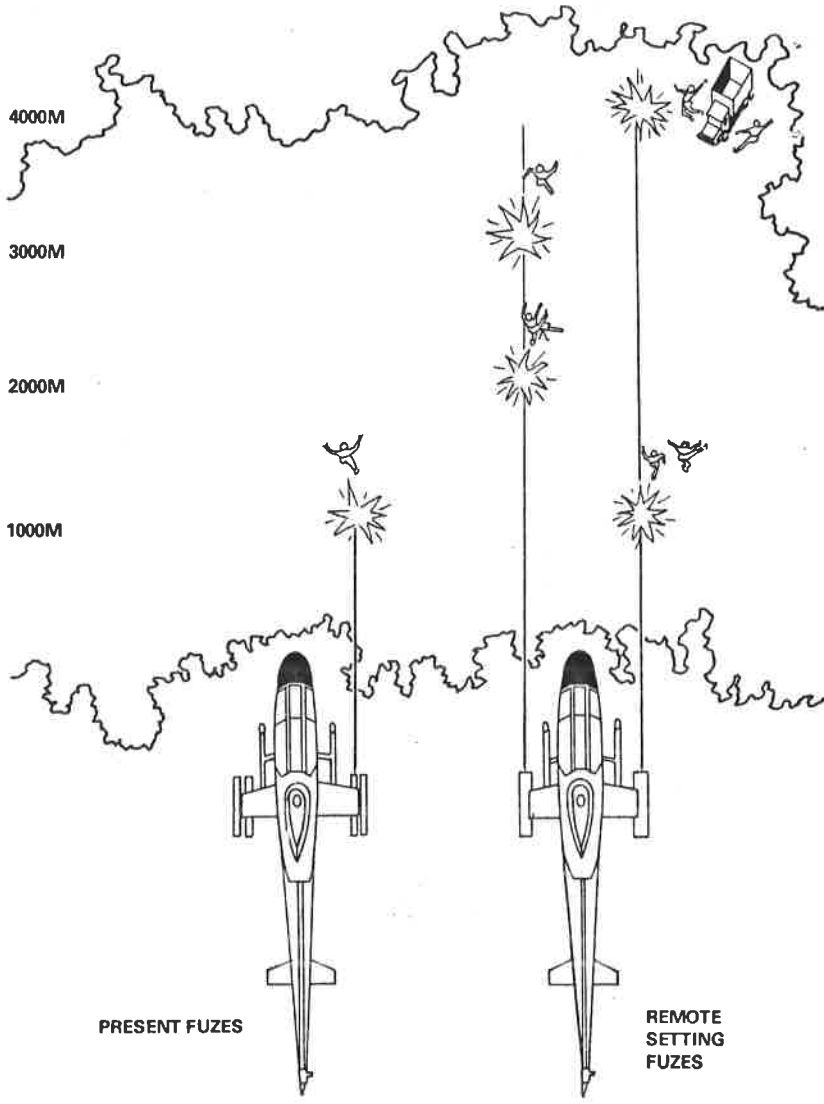
To achieve a successful initial engagement, a system is required which will give the aircrew an accurate means of determining range and to automatically compensate for errors caused by the ballistic characteristics of the different projectiles fired from the attack helicopter. This capability is not available for current model attack helicopters. To attain target data, the aircrew must estimate range. Also, manual corrections must be made to compensate for ballistic error. This procedure is inaccurate and results in range error and large dispersion patterns. The proposed fire control system includes a laser range finder that provides accurate range readouts to targets selected by the aircrew. Additionally, it will provide wind data information to the onboard fire control computer. Finally, information will be displayed in a heads-up display which will compute the aiming point to achieve a first-round hit. This fire control system, which is capable of achieving a first-round hit, is being developed and will be available in the near time frame.

Stores Management

Because of the complexity of targets that may be encountered on the battlefield, there is a need for the attack helicopter to be armed with a more diversified payload. Associated with this requirement is the need for a system to provide information to the aircrew regarding the status of rocket inventory during each mission, by type, quantity, and location. The current system on the AH-1G helicopter limits selection to only two configurations of rockets: selectivity is limited to either inboard or outboard launcher stores. The firing rate is limited to six pairs of rockets per second, which are launched in a fixed sequence. Inventory is maintained by a manual scorecard or memory. Storage management systems are being developed which can provide the aircrew the capability to select and fire, while in flight, any one of four to six external stores. Additionally, this system will give the aircrew the capability to remotely control the fuzing of the warhead. Although the current inventory of attack helicopters is not equipped with a stores management system, it is anticipated that the capabilities of this system will be available in the very near future. Commanders and aircrews should consider the expanded capabilities of a stores management system and plan for its operational use.

Remote Set Fuzing

Attack helicopters are severely limited in providing effective rocket fire against many of the targets that may be encountered on the battlefield. A deficiency that exists is the lack of variable fuzing for both high explosive rocket warheads and for canister (flechette) warheads. With these warheads, the aircrew must select either a point detonating or a present time fuze when the ordnance is loaded aboard the aircraft. If the target to be engaged is protected by a canopy or the range to the target is greater than 1,500 meters, warheads armed with a present time fuze lose their effectiveness. Normally, attack helicopter elements employ a standard tactical munition load concept geared to the type target most frequently encountered. Because of the lack of flexibility of the present fuze options, responsiveness has become subordinate to munition effectiveness. Remote setting fuzes are being tested which will alleviate the above deficiencies for near-term operational use. These new electronic time fuzes provide the aircrew a capability to vary standoff range and effectively engage targets which currently are not vulnerable to rocket fire or which jeopardize helicopter survivability. Commanders and attack helicopter aircrews should consider the expanded capability of the electronic fuze setter and plan for its operational use.



Foldout

SUMMARY

To improve the capability of the attack helicopter to defeat an enemy who possesses sophisticated weaponry, better ammunition and weapons systems are being developed. These improvements include the development of new warheads, a remote fuzing device for the warheads, a stores management system, and a new fire control system. Among the new warheads is the illumination flare (M257). It is capable of producing 1 million candlepower of illumination for a period of 2 minutes. This new warhead gives the attack helicopter aircrew the capability to illuminate the target from a safe distance and from a low altitude. When employed in pairs, it will illuminate an area 1,200 meters in diameter with sufficient light to identify a tank from a distance of 2,000 meters. Larger areas can be illuminated by firing the flares so that they ignite at different points. The flare rocket can be launched using either direct or indirect fire while at a hover or during running fire.

The smoke warhead provides the attack helicopter aircrew a means of establishing protection from visual acquisition. The smoke pattern is dependent upon the air density, the wind velocity, and the atmospheric cooling condition. The greatest effect on the use of smoke is wind. As a rule of thumb, the point of impact should be moved upwind 100 meters for each 5 knots of wind. To achieve optimum results, a large volume of fire in a short period of time is required. The normal burning time is 5 minutes. To sustain continuous coverage of an area with smoke, the time interval between firings should be approximately 4 minutes.

The chaff warhead will provide the needed protection for aircrews to prevent or degrade acquisition by enemy radar. To achieve the protection afforded by the chaff rocket, the helicopter must be in close proximity behind, below, beside, above, or within the chaff cloud. Atmospheric conditions determine how long the chaff cloud will maintain sufficient density to defeat the enemy acquisition capability.

To improve the accuracy of the 2.75-inch FFAR, the submunition concept for firing rockets has been developed. This principle incorporates a remotely controlled set time fuze from the cockpit which functions at a desired range and causes the bomblets to fall in a nearly vertical direction over the target area. Any number of rockets can be fired with the same time setting, resulting in the bomblets falling within the same area. These capabilities are further enhanced by a stores management system being developed which can provide the aircrew the capability to select and fire, while in flight, any one of six external stores.

In addition to the submunition concept for improving helicopter gunnery accuracy, a fire control system is being developed. This system provides accurate range data and a heads-up display which automatically computes the aiming point to achieve a first-round hit.

CHAPTER EIGHT

TRAINING REQUIREMENTS

INTRODUCTION

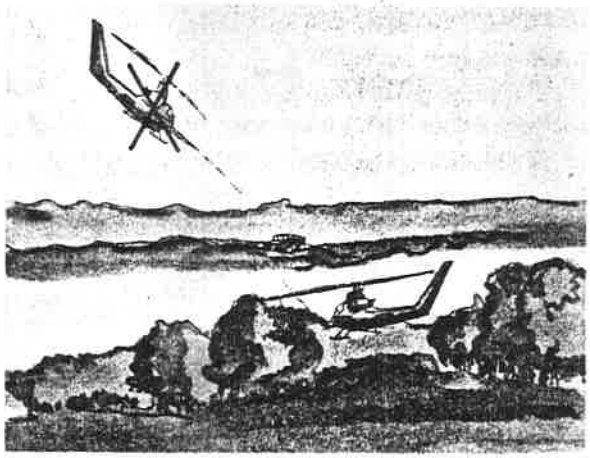
The success of attack helicopter aircrews on the modern battlefield will depend on their ability to place effective fire on the enemy without being destroyed themselves. The training which an aircrew undergoes in preparation for combat will determine the effectiveness of the aircrew. To insure that the aircrews meet the challenge of combat, their training must reflect—to a greater degree than ever before—the environment that they can expect to encounter on the battlefield. Under the best of conditions, there will be total confusion on the battlefield for the aircrew who is new to combat. Commanders must do everything they can in training to indoctrinate the individual aviator, the attack helicopter aircrews, and attack helicopter teams in what to expect and how to react during that first battle—the battle which we must win. This chapter discusses the factors that must be considered for an attack helicopter unit to conduct a realistic training program.

REALISTIC TRAINING

One of the first ways to enhance combat realism is to eliminate those recurring unrealistic training practices that are sometimes overlooked or ignored. Examples are:

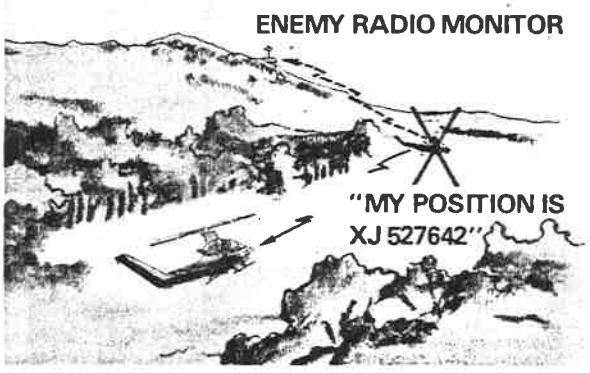
➡ Siting targets in open fields rather than hiding them along tree lines or other concealed positions where the enemy would be.

➡ Remaining unmasked for excessive periods of time.



➡ Conducting diving fire from altitudes which would expose the helicopter to detection by enemy threat weapons.

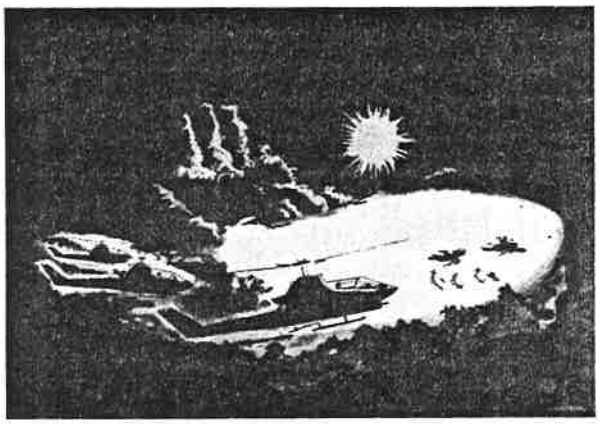
➡ Failing to take advantage of terrain masking while en route to the area of operation.



➡ Failing to use the standoff capability of the weapon subsystems.

➡ Failing to exercise good communications security.

TRAIN USING THE COMBINED ARMS TEAM



TRAIN TO CONDUCT AROUND-THE-CLOCK OPERATIONS

TRAIN TO CONDUCT ALL-WEATHER OPERATIONS

➡Too often safety is cited as a reason for conducting training in a sterile, unrealistic manner. Aviation safety is very important; however, it should not be used as an excuse for conducting unrealistic training. Helicopter gunnery training must be a careful melding of tactical considerations and concern for the safety of the aircrews and civil property.

➡To realize the greatest benefits from training, commanders must carefully manage available resources and make maximum use of new and innovative techniques. New training literature (e.g., TCs, ARTEPs) and training aids developed by the US Army Training and Doctrine Command provide the latest techniques and methods for combat training. They are performance-oriented with emphasis on combat essential missions and functions. Units must train and be evaluated against prescribed standards and previous evaluation results.

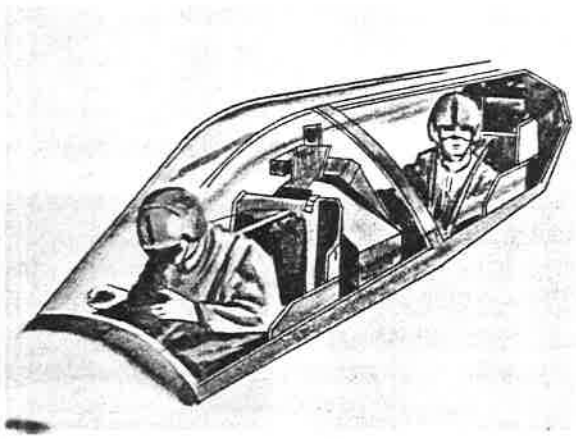
➡Command emphasis must be placed on the requirements to conduct annual qualification training for aircrews of the attack helicopter. Funds which have been allocated for aircraft flying hours and ammunition should not be diverted to other training requirements at post installations. Equal priority must be given to attack helicopter units for use of firing ranges and maneuver areas. If either funds or the facilities is lacking, the state of readiness and the combat effectiveness of a unit is reduced.

"We cannot afford to spend the bravery of our people to make up for our lack of preparation."

AERIAL GUNNERY SKILLS

Aerial gunnery training consists of a progressive building of skills. Coordinated teams and sections require integrated crew training, and integrated crew training requires efficient crewmembers. Therefore, aerial gunnery training must begin with the development of individual skills and progressively build through the crew and team/section levels, with standards of performance set at each level. The recommended aerial gunnery standards for the individual, the crew, and the team/section are contained in chapter 2 of TC 17-17.

INDIVIDUAL



CREW

TEAM/SECTION

TRAINING PROGRAM

To conduct an effective attack helicopter gunnery training program, the following phases of training should be performed:

➡ *Commander's evaluation and planning.* The commander's initial evaluation and planning must precede the other phases, but will continue throughout the entire program. There are five factors which must be considered as part of the evaluation. The first factor is the unit's current proficiency level in aerial gunnery. The commander must then determine what training will be required to initially qualify an aviator to bring him up to the required training standard. This need must then be balanced with the time available to achieve the required training standard. Then the resources required to conduct the training and the resources available to conduct training must be determined.

➡ *Pre-gunnery training.* Pre-gunnery training should prepare the aviator to perform those tasks which will be required for him to conduct successful range training. Some of the subject areas that should be a part of the pre-gunnery training program are shown in table 8-1.

➡ *Aerial gunnery skills test.* The aerial gunnery skills test (AGST) determines if aviators are ready to advance to the range training phase. The test should be conducted far enough in advance of range training to allow for necessary remedial training. It should be comprehensive enough to insure that all skills required for the conduct of the firing tables have been mastered.

➡ *Range training.* The range training phase of the aerial gunnery training program consists of all or portions of the aerial gunnery tables. The recommended tables are divided into three levels of training. The three levels are individual, crew, and team/section training. The tables are presented in TC 17-17 in detail but are summarized below. The individual tables provide a training outline for an aircrewmember to qualify with the weapons systems from the gunner and pilot position. The purpose of the crew tables is to develop the elements of coordination required to weld individuals into qualified aircrews. The skills developed at this level of training are built on the skills which were mastered in the individual tables. The purpose of the team/section tables is to develop the skills and coordination required for attack helicopter aircrews to conduct a coordinated attack (e.g., aeroscouts, ground maneuver elements, and supporting fires).

PRE-GUNNERY TRAINING SUBJECTS

- Flight proficiency training
- Mapreading/navigation/terrain analysis
- Armament
- Ammunition
- Crew duties
- Target acquisition and identification
- Mission planning
- Range operation and safety

TABLE 8-1

COMMAND RESPONSIBILITY

For effective accomplishment of initial and annual helicopter gunner qualification and tactical employment training, commanders should plan and supervise training to insure—

➡Training develops aviator proficiency in individual, crew, and section/team duties.

➡Aviators are given adequate opportunities to maintain the knowledge and skill required to conduct helicopter gunnery.

➡Training is standardized in accordance with TC 17-17.

➡Establishment of criteria to help prevent operational skill fatigue. If for any reason, an aviator's ability to conduct helicopter gunnery is impaired or subject to doubt, the commander should prohibit that individual from participating in training or operations until the circumstances causing that condition have been corrected.

➡It is the attack helicopter unit commander's responsibility to insure that his attack helicopters are employed in training as they would be in the high threat environment.

➡Aviation safety is enforced during all phases of training.

➡That helicopter gunnery training be closely supervised as conditions permit.

➡That ammunition conservation is practiced by each aircrew.

AMMUNITION REQUIREMENTS

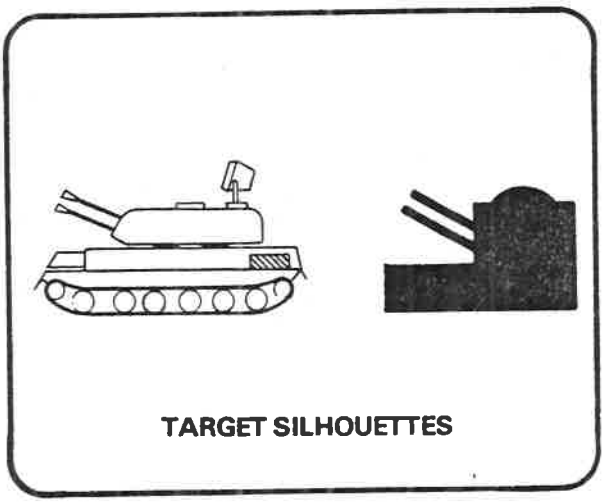
The training to be given to the individual flight crewmember depends upon the qualification table to be fired and the proficiency of the aviator. Initial qualification firing requires sufficient gunnery training for the aviator to attain a satisfactory level of proficiency for firing each armament subsystem. For units authorized local transition into the AH-1G, the recommended ammunition requirements for initial weapon qualification are contained in table E-1, appendix E, TC 17-17.

Annual gunnery qualification is given to maintain the aviator's proficiency at a specified level for firing the armament subsystems assigned to his unit. In addition to individual training, it includes crew and team/section training. For recommended ammunition requirement for annual qualification in the UH-1B/C/M and the AH-1G, see table E-5, appendix E, TC 17-17.

The authorized ammunition allowances for Active Army, Reserve components, and service schools are contained in CTA 23-100-2 and CTA 23-100-6. Commanders are responsible to insure that ammunition expended does not exceed authorized allowances. The firing tables provided in TC 17-17, Gunnery Training for Attack Helicopters, provide a guide for expenditure of ammunition. The amount of ammunition required to attain the desired level of proficiency will vary from one aviator to the other. Expenditure of ammunition beyond what is required to achieve the desired level of proficiency is discouraged. "WASTE NOT; WANT NOT."

TARGETS

To achieve the most benefit from helicopter gunnery training, realistic targets should be used. Salvaged military vehicles (tanks, APC, trucks) are readily available and provide realistic targets. Silhouette targets representative of enemy weaponry also provide good inexpensive targets. By using life-size targets positioned at varying ranges, aircrews become familiar with the target presentation at the different ranges.

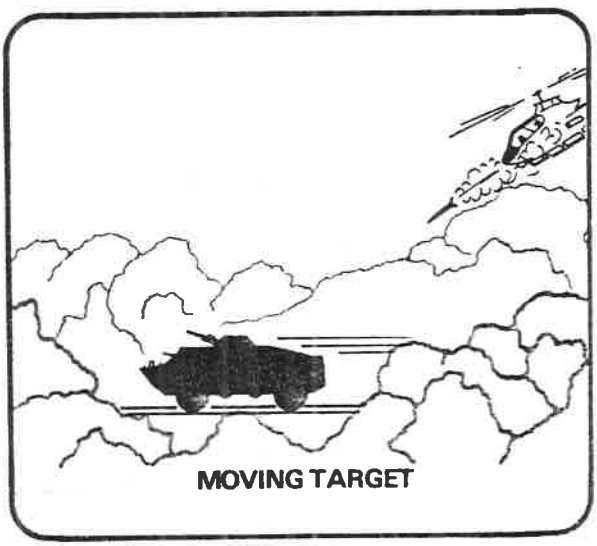


TARGET SILHOUETTES

TARGET POSITIONING

Realism must be achieved when positioning the targets on the range. A few targets exposed on prominent terrain are required to train new aircrews; however, targets should be tactically employed to familiarize aircrews with what to expect and how to react when actually engaged in combat. Both linear (vehicle road column) and area (armor attack formation, logistical complex) targets should be used. Multiple firing points from which these targets can be attacked should be used.

Finally, some targets must be capable of moving at the approximate speed of threat armor vehicles. It can be anticipated that enemy armor will conduct evasive maneuvers to reduce their vulnerability to the attack helicopter. To develop proficiency in attacking moving targets, aircrews must train using moving targets. The construction and tactical employment of target arrays are discussed in more detail in appendix E of TC 17-17, Gunnery Training for Attack Helicopters.



MOVING TARGET

SCORING

Initial and annual firing exercises must be scored to assess the qualifications of the aviator as a member of an attack helicopter crew. The visual method, whereby the examiner scores the firing exercise while acting as a crewmember or observing from an aircraft overflying the target, is the only means currently available to objectively determine the ability of the aviator to place effective fire on the target. The use of the scorecard and the criteria for awarding points are discussed in detail in appendix D of TC 17-17, Gunnery Training for Attack Helicopters. The factors which should be considered in computing the score an aviator achieves during qualification firing are:

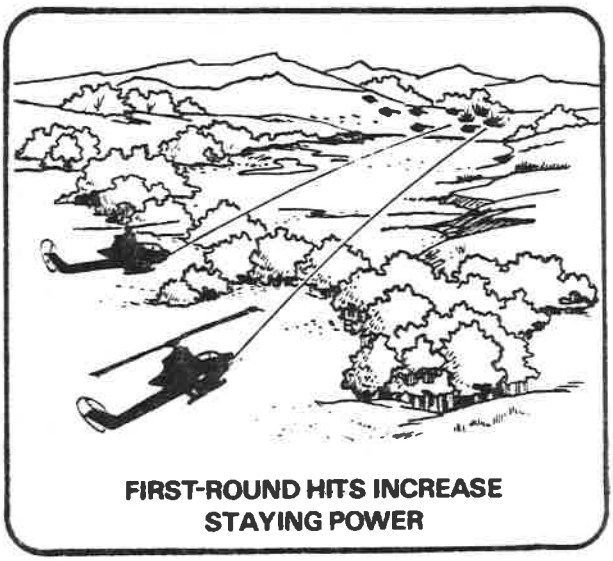
➡ *Target effect*— engaging the target with the weapon which will most efficiently achieve the desired results and the number of hits within the kill zone of a target.

➡ *Aircraft exposure time*—presenting the minimum opportunity for the enemy to engage the aircraft while successfully completing the engagement.

➡ *Technique of target attack*—selecting and implementing the method of engagement (flight mode and type firing) which will maximize the advantages and minimize the disadvantages of a given situation.

➡ *Efficient use of ammunition*—achieving the desired target effect with the minimum expenditures of ammunition. POINTS ARE AWARDED FOR UNEXPENDED ROUNDS.

TARGET EFFECT IS DETERMINED BY THE NUMBER OF ROUNDS IN THE KILL ZONE



FIRST-ROUND HITS INCREASE STAYING POWER

SUMMARY

The success of an attack helicopter aircrew on the battlefield will largely depend on the quality of training it receives in preparation for combat. To insure that the aircrew meets the challenge of combat, training must reflect—to a greater degree than ever before—the environment that it can expect to encounter on the battlefield. One of the first ways to enhance combat realism is to eliminate those recurring unrealistic training practices. Aviation safety is very important; however, it should not be used as an excuse for conducting unrealistic training. Commanders must carefully manage available resources and make maximum use of new and innovative training techniques. Emphasis must be placed on the requirement to conduct annual qualification training. Gunnery training must begin with the development of individual skills and progressively build through the crew and team/section level with standards of performance set at each level.

To conduct an effective attack helicopter gunnery training program, the following phases of training should be performed:

- Commander's evaluation and planning
- Pre-gunnery training
- Aerial gunnery skill test
- Range training

After a training program has been established, the commander must supervise the training program to insure that it is implemented as planned and that it meets the needs of the individual/unit.

The training to be given an individual flight crewmember depends upon the qualification table to be fired and his proficiency. The amount of ammunition required to attain the desired level of proficiency will vary from one aviator to the other. Expenditure of ammunition beyond what is required to achieve the desired level of proficiency is discouraged.

To achieve the most benefit from helicopter gunnery training, realistic targets should be used. These targets must be tactically employed to familiarize aircrews with what to expect and how to react when actually engaged in combat. Additionally, some targets must be capable of moving at the approximate speed of threat armored vehicles.

Initial and annual firing exercises must be scored to assess the qualification of the aviator as a member of an attack helicopter crew. The factors which should be considered in computing the score an aviator achieves during qualification firing are:

- Target effect
- Aircraft exposure time
- Technique of target attack
- Efficient use of ammunition

CHAPTER NINE

AERIAL DOOR GUNNER TRAINING

INTRODUCTION

Helicopter door gunnery consists of those techniques used to acquire and engage enemy personnel and other targets while operating at terrain flight altitudes. Specifically, the door gunner visually acquires and identifies potential and actual enemy targets during rapidly moving battlefield situations and responds by providing suppressive fires on those targets. This chapter discusses warning systems used by the door gunner and the techniques required by the gunner to place effective fire on a target.

LIMITATIONS

Helicopter door gunnery in a high threat environment will present new challenges to old problems. "Door gunnery," in principle, has not changed; it still consists of a team—the pilot who provides early warning of targets to be engaged and the gunner who operates one machinegun in an effort to suppress or destroy the enemy. However, the door gunner's environment is now different. His environment has changed as a result of three factors—the high threat battlefield, terrain flight, and aircraft design changes.

The high threat battlefield means the door gunner must be concerned with an enemy threat that will be more complex, sophisticated, and lethal than ever before. This requires that his target acquisition efforts must be extended beyond the immediate area of the aircraft for he must be concerned with the very real possibility that his aircraft may be engaged by hostile aircraft.

Terrain flying means the door gunner and his aircraft are more vulnerable to small arms fire. It also means target acquisition is more difficult because the terrain may allow only a cursory glimpse of the enemy. This will require immediate identification and engagement almost to the point of firing by instinct. Also, the door gunner must continuously divide his attention between observation and assisting in obstacle clearance.

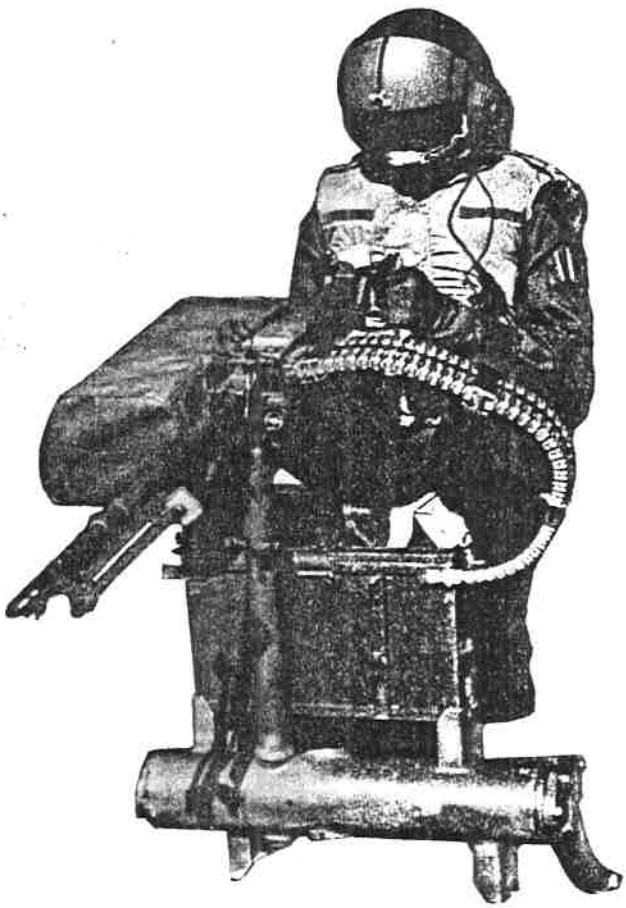
Aircraft design change means the forward field of view of the gunner will be restricted; therefore, closer coordination is required between the pilot/copilot and the gunner to insure accurate handoff with minimum delay.

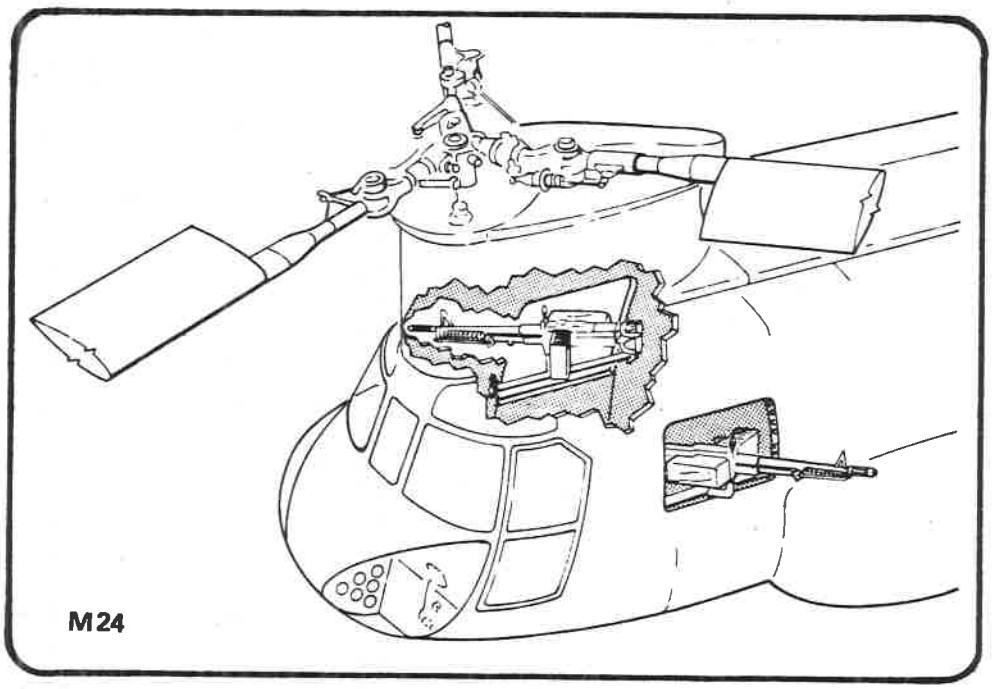
UTILITY AND CARGO HELICOPTER ARMAMENT

The basic weapon for the helicopter door gunner is the M60D, 7.62mm machinegun. There are currently three armament subsystems in use for the utility and cargo helicopter which vary only in mounting, auxiliary equipment, and basic load. Detailed descriptions of these subsystems are contained in TM 9-1005-262-15.

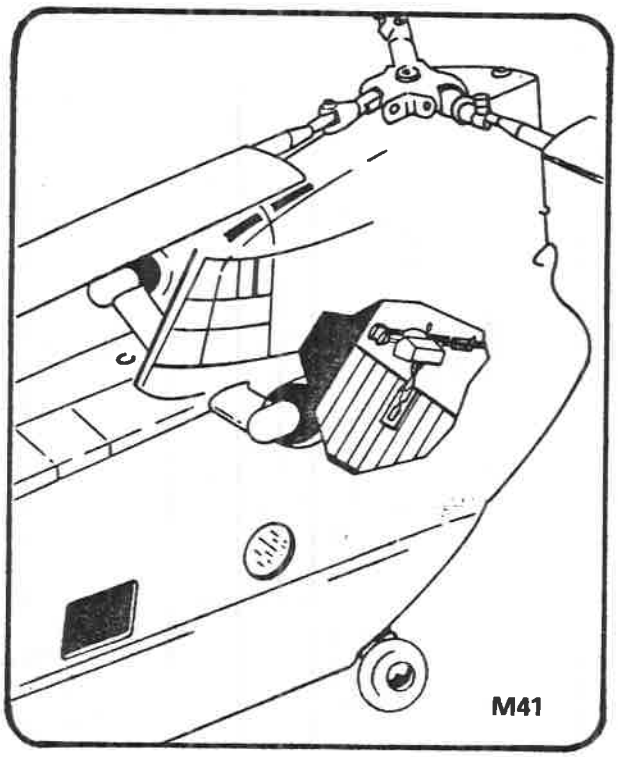
M23 Machinegun System

UH-1 helicopters utilize the M23 armament subsystem. This subsystem consists of two machinegun assemblies, one mounted in each of the aircraft's cargo doorways.





M24 and M41 Machinegun Systems



CH-47 helicopters utilize either the M24 or the M41 armament subsystem. The M24 subsystem consists of two machinegun assemblies, one mounted in the cabin doorway (right side), the other mounted on the escape hatch (left side). The M41 subsystem consists of one machinegun assembly mounted on the aircraft's cargo ramp.

DOOR GUNNER TRAINING PROGRAM

The tables of organization and equipment (TOE) for units equipped with utility or cargo helicopters are augmented with door gunner personnel. The augmentation aspect creates a training dilemma—door gunners are a tactical necessity and must be trained, yet such personnel are seldom, if ever, found in units during peacetime. Ideally, in the event of mobilization and deployment, qualified door gunners will be school trained and assigned to such units. Therefore, very few aviation units currently conduct door gunner training. However, unit commanders must be prepared not only to integrate qualified door gunners into their training program if assigned, they should also be prepared to conduct their own training program for newly assigned personnel or even train door gunners from their current personnel assets. In reality, anyone in a unit may be called upon to perform the duties of a door gunner. The possibilities will cover the entire spectrum from company clerks to wheeled-vehicle mechanics, with the distinct possibility that none may be qualified with the M60 machinegun.

UNIT COMMANDERS MUST BE PREPARED TO CONDUCT THEIR OWN DOOR GUNNER TRAINING PROGRAM.

Given the wide range of individual qualifications, the door gunner training program should be highly flexible and "open ended." Each individual assigned to a unit as a door gunner must be evaluated to assess the amount and type of training he will require. For example, a school trained door gunner could be integrated into mission type training, whereas another individual who is only M60 qualified would be integrated into the aerial gunnery phase of training. Appendix D contains a recommended aerial door gunner training program. This program will qualify any individual in the techniques, skills, and duties of the door gunner. The primary emphasis is placed on initial weapons qualification, aerial firing qualification, and target acquisition. Priorities for training are suggested by the categorizing of subjects into modules containing subjects ranked by criticality. For example, the first module is basic weapons qualification and is a prerequisite to the second module, aerial qualification. Within the weapon qualification module, the various subjects are listed in the order of their importance. Each module is the building block which provides the foundation for the next module. The first three modules contain the basic door gunner qualification course. The last module contains allied subjects that may be added to the basic course commensurate with additional duties assigned to the door gunner. The training program may, therefore, be modified and designed to meet the needs of the unit and the individual concerned.

THE TRAINING PROGRAM SHOULD BE DESIGNED AND MODIFIED TO MEET THE NEEDS OF THE UNIT AND THE INDIVIDUAL CONCERNED.

Fundamentals of Fire Control

Fire control, or weapon control, is the name given to all the observations, calculations, and actions involved in aiming a weapon. Broadly defined, fire control includes all means of directing missiles of all kinds in such a way that they will strike the target.

Basically, the gun must be aimed correctly at the instant it is fired; that is, it must be pointed in such a direction that the projectile will hit the target. Aiming a stationary gun at a stationary target in a "force-free field" would require simply pointing the gun at the target. However, firing never occurs in a force-free field and a door gunner's weapon is seldom stationary, much less his target.

All the factors that determine the amount of offset are estimated by the gunner. He leads the target by what seems to be the correct amount and makes adjustments by trial and error. The factors which will affect the door gunner's accuracy are identical to those ballistic factors for weapons fired in the flex mode as discussed in chapter 2.

Gravity exerts a constant force which pulls the projectile toward the Earth (gravity drop). Air resistance tends to decrease the initial velocity of the projectile (drag). Moving air (wind) tends to deflect the projectile from its predetermined trajectory (wind drift). A certain amount of deflection is inherent in the gun caused by the spin which is imparted to the projectile (projectile drift). A projectile will tend to deflect in the direction in which the aircraft is moving when the weapon is fired (trajectory shift). When firing from the left side of the aircraft, the deflection caused by shift and drift are both to the right; whereas, when firing from the right side of the aircraft, shift and drift are in opposite directions and tend to cancel each other (port-starboard effect). When firing from a moving helicopter, the spin of the projectile will combine with the crosswind to deflect the projectile. When firing from the right, the crosswind will be from the left and will combine with the projectile spin and cause the projectile to deflect slightly downward. When firing from the left, the crosswind will be from the right and will combine with the projectile spin causing the projectile to deflect slightly upward (projectile jump). The effects of all these factors depend on the distance the projectile must travel. Target range, thus, becomes extremely important. When the target is moving, an additional compensation must be made, because the target will change position during the projectile's time of flight. To hit the target, the gun must be aimed not at the target, but at the point in space where the target will be when the projectile arrives.

In nearly all gun systems, the basic elements are the same. The "line of sight" is the direction from the gun to the target. In order to hit the target, the "line of aim" is offset from the line of sight by an amount determined by:

- Target motion
- Gun station (helicopter) motion
- Range
- Gravity drop of the projectile
- Windage
- Characteristics of the gun and projectile

FIRING TECHNIQUES

The door gunner and his instructor must realize that aerial firing and sighting are a very complex problem of speeds, ranges, firing angles, and ballistics. The following are some of the door gunner's problems as compared with those of a ground gunner.

➡ The door gunner's firing platform is always moving. The ground gunner usually fires from a stationary platform.

➡ The door gunner has a very difficult problem of range, while the ground gunner can make use of range finders, maps, or known ground reference points to determine range more easily.

➡ The door gunner is mainly on his own as to his fire control and conservation of ammunition.

➡ The door gunner must act in a split second. He does not have the time that the ground gunner has to compute his aim carefully.

Range estimation is the first step that the door gunner takes in preparing to shoot at a target. Door gunners should practice range estimation throughout their training. In order for range estimation to be of any value under combat conditions, it is necessary for all gunners to recognize ranges instantly and accurately. The time it takes the projectile to reach the target will determine how much the projectile will be affected by all the ballistic factors previously discussed.

By combining all the ballistic factors and taking the range to the target into consideration, there are two simple rules of thumb for engaging targets from a moving helicopter.

> Rule 1: "When firing from the right side of the helicopter, aim high and to the near side of the target."
>
> Rule 2: "When firing from the left side of the helicopter, aim low and to the near side of the target."

In both rules, the aiming point is to the near side of the target because the motion of the aircraft and the effects of projectile drift will carry the bullet forward. The amount of forward movement is greater on the left side than on the right side because of port starboard effect. The difference between aiming high or low is caused by the effects of projectile jump.

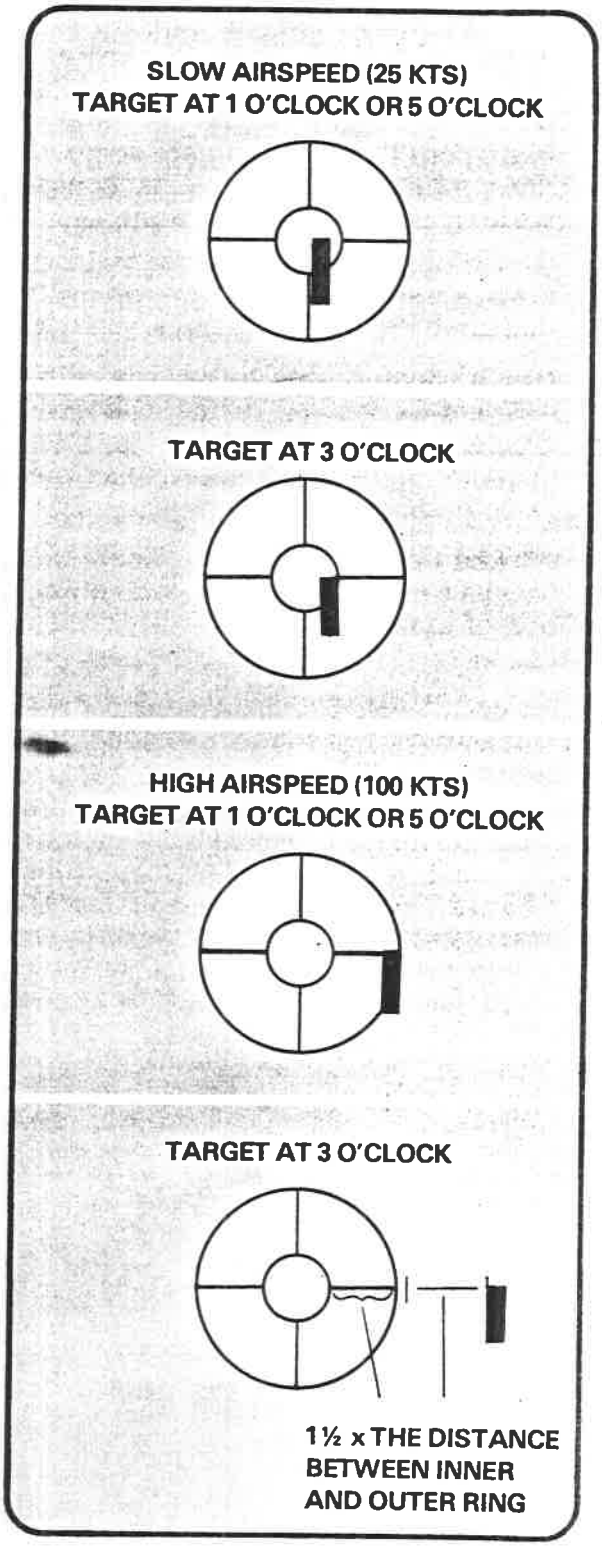
SIGHT PICTURES

The M60D machinegun has a front blade sight and a rear ring sight. Placing the horizontal crosshair of the rear ring sight and the top of the front blade sight on line with the aiming point will compensate for the effects of gravity drop at ranges up to 750 meters. The gunner must aim higher at ranges beyond 750 meters.

To properly "lead the target," the gunner must align the target and front blade sight with an appropriate point on the horizontal crosshairs depending on aircraft speed, the side from which the gunner will be firing, and the firing angle. A proper sight picture for engaging a target using rule 1 (high and behind) is illustrated. (Four separate sight pictures are shown.)

In each case, the proper sight picture automatically "points" the weapon to the near side of the target. The sight pictures for firing from the left side of the helicopter are the same except that the gunner will use the left half of the rear sight ring and use rule 2 and place the target slightly above the front blade sight, thereby firing low and to the near side of the target.

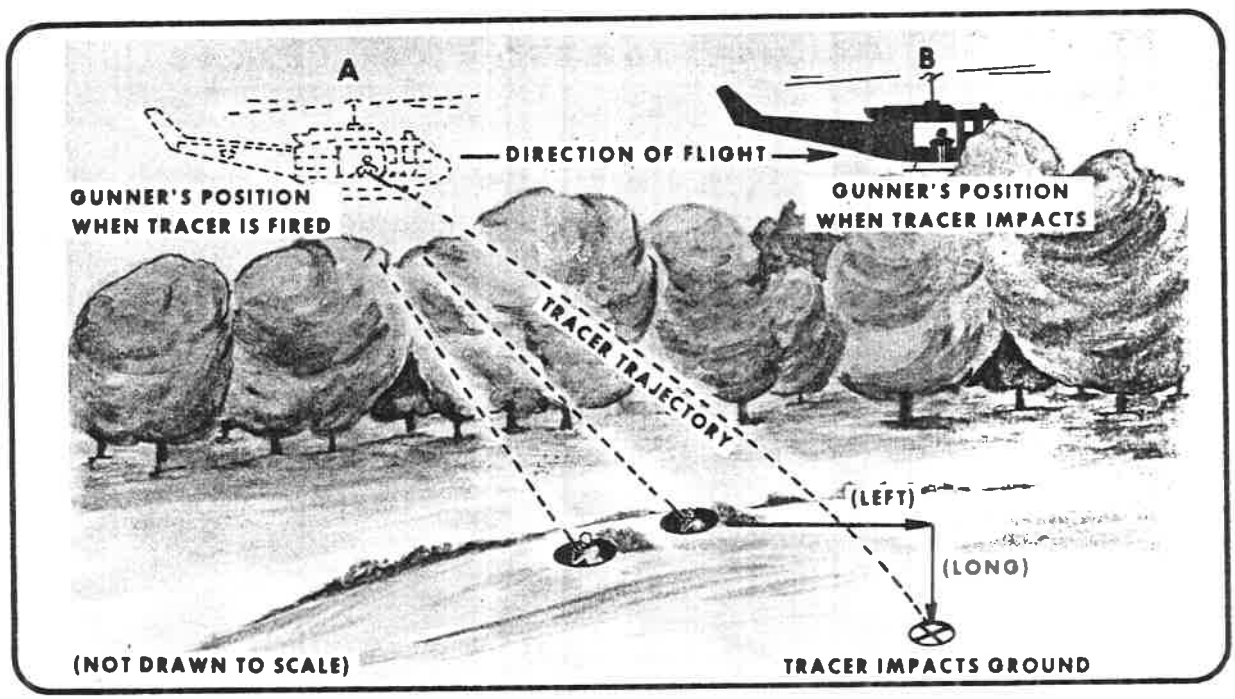
As the gunner's ability to estimate lead angle improves, more accurate and immediate fire may be achieved by directly aligning the rear and front sights and displacing this sight picture either left or right of the target.


SLOW AIRSPEED (25 KTS)
TARGET AT 1 O'CLOCK OR 5 O'CLOCK
TARGET AT 3 O'CLOCK
HIGH AIRSPEED (100 KTS)
TARGET AT 1 O'CLOCK OR 5 O'CLOCK
TARGET AT 3 O'CLOCK
1½ x THE DISTANCE BETWEEN INNER AND OUTER RING

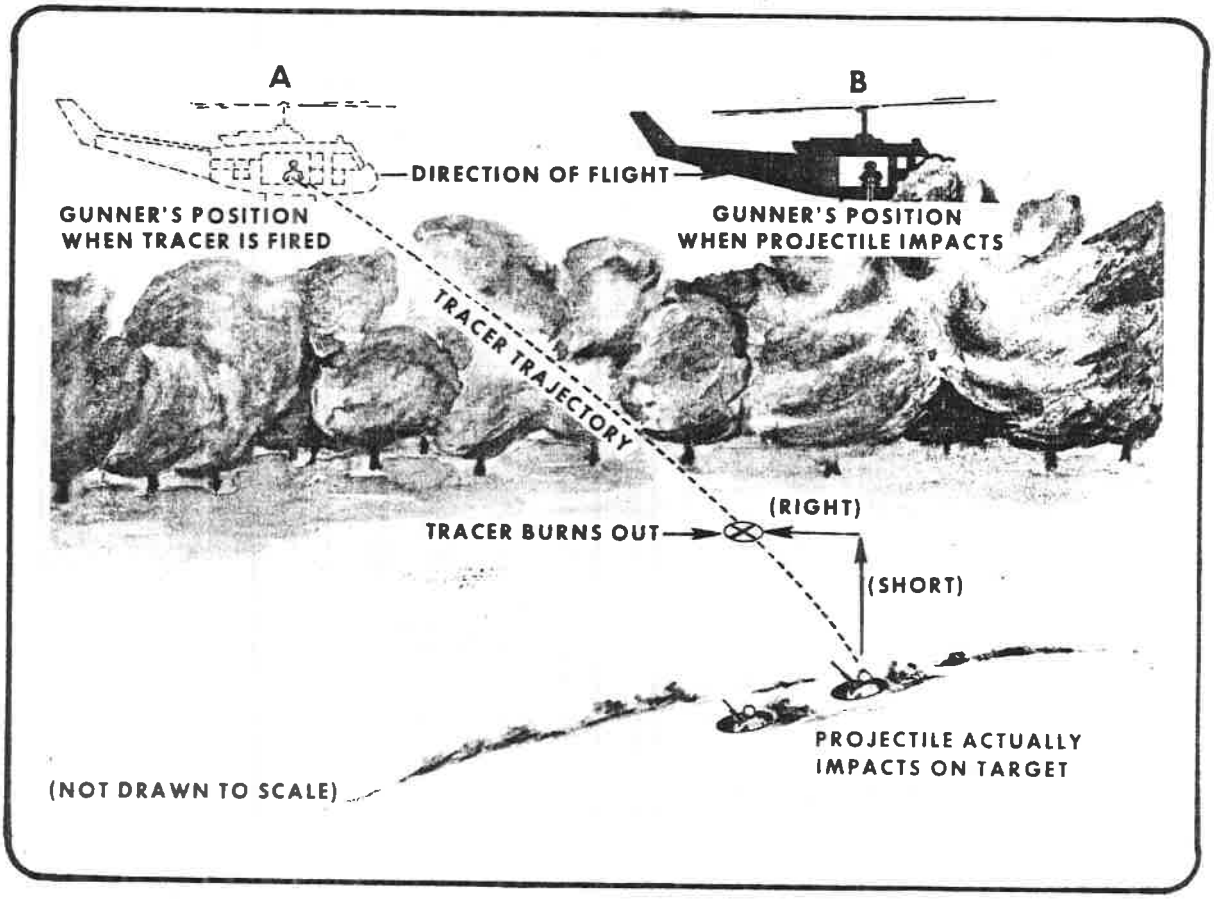
FIRE ADJUSTMENT

The door gunner adjusts his fire by either observing bullet impact or tracer trajectory. The standard 4-1, linked ammunition (four rounds of ball to one round of tracer) will provide a sufficient number of tracers for effective fire adjustment. However, for training purposes, firing solid tracer greatly assists the door gunner in learning. The door gunner must be aware of the disadvantage of adjusting fire, using tracers. This disadvantage is called observer shift and occurs primarily at longer ranges, becoming more pronounced at higher airspeeds. There are two versions of observer shift: one which occurs before tracer burnout and one which occurs after tracer burnout.

In the figure below, the gunner fires at a target from position A but has aimed slightly too high. The projectile then traveled directly over the target and impacted behind the target. By the time the round impacted, the gunner had moved along the flightpath to position B while constantly watching the tracer trajectory. Because of his change in position, he is led to believe that he has not only aimed too high, but also to the left.



Observer shift is also deceptive when the gunner is firing at a target that is beyond tracer burnout. In the figure below, the gunner fires at a target from position A. As the tracer travels toward the target, the gunner's helicopter has traveled to position B along its flightpath. When the tracer disappears, the gunner concludes (incorrectly) that he has aimed low and to the right; when in reality, the bullet continued along its trajectory and struck the target. The solution to observer shift is awareness and training.



SUMMARY

Helicopter door gunnery consists of those techniques used to acquire and engage enemy targets while operating at terrain flight altitudes. Target acquisition is more difficult when flown at terrain flight altitudes due to the short time and distance that a target can be viewed.

The basic weapon for the helicopter door gunner is the M60D, 7.62mm machinegun. There are three armament subsystems in use for the utility and cargo helicopter. The UH-1 helicopter utilizes the M73 armament subsystem. To qualify door gunners on these weapons subsystems, the training program should emphasize weapon qualification, aerial firing qualification, and target acquisition.

In order to hit a target, the gunner must aim the gun correctly the instant it is fired. When firing from a stationary position at a stationary target, the gunner simply points the gun at a target. However, when firing from a helicopter, the firing position is seldom stationary. In order to hit the target, the line of aim is offset from the line of sight by an amount determined by:

- Target motion
- Gun station (helicopter) motion
- Range
- Gravity drop of the projectile
- Windage
- Characteristics of the gun and projectile

The ballistic factors which affect the door gunner's accuracy are identical to the factors affecting weapons fired in the flex mode as discussed in chapter 8. The ability of the gunner to compensate for ballistic error will not improve his accuracy unless range estimations are accurately judged. By combining all the ballistic factors and accurate range estimation, the gunner can hit the target. There are two simple rules of thumb for engaging targets from a moving helicopter:

1. When firing from the right side of the helicopter, aim high and to the near side of the target.

2. When firing from the left side of the helicopter, aim low and to the near side of the target.

Because door gunner training is given very little emphasis during peacetime, there are very few qualified door gunners. In the event of an armored conflict, it can be anticipated that commanders will be responsible for the training of door gunners within their unit. Appendix D contains a recommended aerial door gunner training program which can be used to qualify newly assigned personnel as door gunners.

APPENDIX A

REFERENCES

PUBLICATION INDEXES

Department of the Army Pamphlets of the 310-series should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to material covered in this manual.

ARMY REGULATIONS (AR)

95-series	(Aviation)
310-25	Dictionary of United States Army Terms
310-50	Authorized Abbreviations and Brevity Codes
350-1	Army Training
350-4	Qualification and Familiarization with Weapons and Weapons Systems
385-62	Firing Guided Missiles and Heavy Rockets for Training; Target Practice, and Combat
385-63	Regulation for Firing Ammunition for Training, Target Practice, and Combat

DEPARTMENT OF THE ARMY PAMPHLETS (DA PAM)

310-series	(Military Publications Indexes)

FIELD MANUALS (FM)

1-1	Terrain Flying
1-5	Instrument Flying and Navigation for Army Aviators (Replacing TM 1-215 and TM 1-225.)
1-51	Rotary Wing Flight
1-60	Army Air Traffic Management in the Combat Zone
1-80	Aerial Observer Techniques and Procedures
1-105	Aviator's Handbook
6-102	Field Artillery Battalion, Aerial Field Artillery
17-1	Armor Operations
17-37	Air Cavalry Squadron
17-45	Air Cavalry Combat Brigade (To Be Published)

17-50	Attack Helicopter Operations (To Be Published)
17-95	Cavalry (To Be Published)
24-1	Tactical Communications Doctrine
30-5	Combat Intelligence
44-30	Visual Aircraft Recognition
90-1	Employment of Army Aviation Units in a High Threat Environment

TRAINING CIRCULARS (TC)

1-16	Employment of Aircraft Flares From Army Aircraft (To be Published)
1-20	Aeromedical Training for Flight Personnel
1-28	Rotary Wing Night Flight
1-88	Aviator's Recognition Manual (To Be Published)
17-17	Gunnery Training for Attack Helicopters

TECHNICAL MANUALS (TM)

9-1005-257-12	Operator and Organizational Maintenance Manual: Armament Pod, Aircraft, 7.62-mm Machine Gun: M18 (1005-930-5597) Armament Pod, Aircraft, 7.62-mm Machine Gun: M18A1 (1005-832-7498)
9-1005-262-14	Operator, Organizational, Direct Support, and General Support, Maintenance Manual: Armament Subsystem, Helicopter, 7.62-mm Machine Gun: Door Mounted, Lightweight, M23 (1005-907-0720) (Used on UH-1D/UH-1H Helicopters); Armament Subsystem, Helicopter, 7.62-mm Machine Gun: Door Mounted, Lightweight, M24 (1005-763-1404) (Used on CH-47 series Helicopters); and Armament Subsystem, Helicopter, 7.62-mm Machine Gun: Ramp Mounted, Lightweight, M41 (1005-087-2046) (Used on CH-47 series Helicopters)
9-1005-298-12	Operator and Organizational Maintenance Manual: Armament Subsystem, Helicopter, 7.62-mm Machine Gun; High Rate, M27 (1005-933-6242) (Used on OH-6A and OH-58A Helicopters)

9-1005-299-12	Operator and Organizational Maintenance Manual: Armament Subsystem, Helicopter, 20 Millimeter Automatic Gun, M35 (1005-133-8193) (Used on AH-1G Helicopter)
9-1010-207-12	Operator and Organizational Maintenance Manual: Armament Subsystem, Helicopter, 40 Millimeter Grenade Launcher: M5 (1010-738-5811) (Used on UH-1B or UH-1C Helicopters)
9-1090-202-12	Operator and Organizational Maintenance Manual: Armament Subsystem, Helicopter, 7.62 Millimeter Machine Gun, 2.75-Inch Rocket Launcher: M21 (1090-923-5971) (Used on UH-1B and UH-1C Helicopters)
9-1090-203-12	Operator and Organizational Maintenance Manual: Armament Subsystem, Helicopter, 7.62 Millimeter Machine Gun - 40 Millimeter Grenade Launcher: M28 (1090-933-6071) and Armament Subsystem, Helicopter, 7.62 Millimeter Machine Gun - 40 Millimeter Grenade Launcher: M28A1 (1090-134-3071) (Used on AH-1G Helicopter)
9-1090-204-12	Operator and Organizational Maintenance Manual: Mount, Multiarmament, Helicopter: XM156 (1090-930-5018) (Used on UH-1B or UH-1C Helicopters)
9-1300-200	Ammunition, General
9-1300-206	Ammunition and Explosive Standards
9-1340-201	2.75-Inch Folding-Fin Aircraft Rocket
9-1400-461-20	Organizational Maintenance Manual: Guided Missile Launcher, Helicopter Armament Subsystem M22 (Used on UH-1B Helicopter)
9-4933-211-14	Operator's Organizational, Direct Support, and General Support Maintenance Manual For: Power Supply, Hydraulic/Electric, Portable; (4933-00-933-4742) (Used with M5, M18 (XM18), M18A1 (XM18E1), M21, XM27E1, M28 (XM28), M28A1 (XM28E1), M35 (XM35) and XM156 Aircraft Armament Subsystem)
9-6920-461-12	Organizational Maintenance Manual: Guided Missile Flight Control Training Set DX-43 and DX-44 (ENTAC Antitank Guided Missile System and M22 Guided Missile Launcher Helicopter Armament Subsystem)
55-1520-219-10	Operator's Manual: Army Model UH-1B Helicopter

55-1520-219-20	Organizational Maintenance Manual: Army Model UH-1B Helicopter
55-1520-220-10	Operator's Manual: Army Model UH-1C/M Helicopters
55-1520-220-20	Organizational Maintenance Manual: Army Model UH-1C/M Helicopters
55-1520-221-10	Operator's Manual: Army Model AH-1G Helicopter
55-1520-221-20	Organizational Maintenance Manual: Army Model AH-1G Helicopter

COMMON TABLES OF ALLOWANCES (CTA)

23-100-6	Ammunition, Rockets, and Missiles for Unit Training Active Army and Reserve Components

ARMY TRAINING AND EVALUATION PROGRAM (ARTEP)

17-37	Air Cavalry Squadron and Air Cavalry Troop
17-385	Attack Helicopter Battalion

APPENDIX B

GLOSSARY

GENERAL

Ballistic Correction—The adjustment of firing data that is based on conditions affecting the flight of the projectile. For the attack helicopter, ballistic data is the difference between the mil setting on the M73 gunsight which resulted in the projectile hitting the target and the mil setting on the sight card for the specific range, quadrant elevation, and airspeed.

Delivery Technique—The maneuver performed by the pilot to position the helicopter in the proper pitch attitudes and align the helicopter in order for a projectile to hit the target or for a flare rocket to ignite over the target area.

Ignition Point—A point over the target area where flare ignition occurs. Depending on the size of the target, one or more ignition points may be required to illuminate the target.

Reference Point—An aiming reference established on the M73 sight reticle by the pilot for the adjustment of fire onto the target. The position of the reference point may be mentally noted by the pilot or it may be marked on the beamsplitter as a visual reference.

Standard Turret Loading—It is the baseline from which adjustments for range are made to compensate for a nonstandard loading configuration. The standard turret load used to develop the sight cards for the attack helicopter is one M134 machinegun and one M129 grenade launcher with the ammunition magazines loaded to one-half capacity.

MODES OF FIRE

Direct Fire—Fire delivered on a target using the target as a point of aim.

Indirect Fire—Fire delivered on a target where sources other than the target are used as a point of aim.

FIRE ADJUSTMENT

Observer Correction—It is the distance (both laterally and in range) that the impact point of a projectile must be moved to hit a target as viewed from the observer's position.

Aircrew Correction—It is the distance (both laterally and in range) that the impact point of a projectile must be moved to hit a target as viewed from the point of origin.

TYPES OF TARGETS

Preplanned—Targets that are planned prior to takeoff. Normally, sufficient time is available to conduct detailed planning.

Targets of Opportunity—Targets detected by scout helicopter aircrews while searching the battlefield for the enemy. Planning by the attack helicopter aircrew is limited due to the short response time required to gain a tactical advantage.

Immediate Reaction—A target that appears while being directed by the scout aircrew to attack a target of opportunity or while en route or returning from an attack on a preplanned target which requires immediate action by the aircrew to gain tactical advantage. Prior planning is limited only to unit SOP's that have been established for this type of target.

TYPES OF FIRE

Stationary Hovering Fire—Fire delivered from any altitude that permits effective target engagement while the firing helicopter remains stationary over a point on the ground.

Moving Hovering Fire—Fire delivered from any altitude that permits effective target engagement while the firing helicopter moves across the ground below the airspeed of effective translational lift.

Running Fire—Fire delivered from helicopter in forward terrain flight.

Diving Fire—Fire delivered from a helicopter while at altitude in descending forward flight.

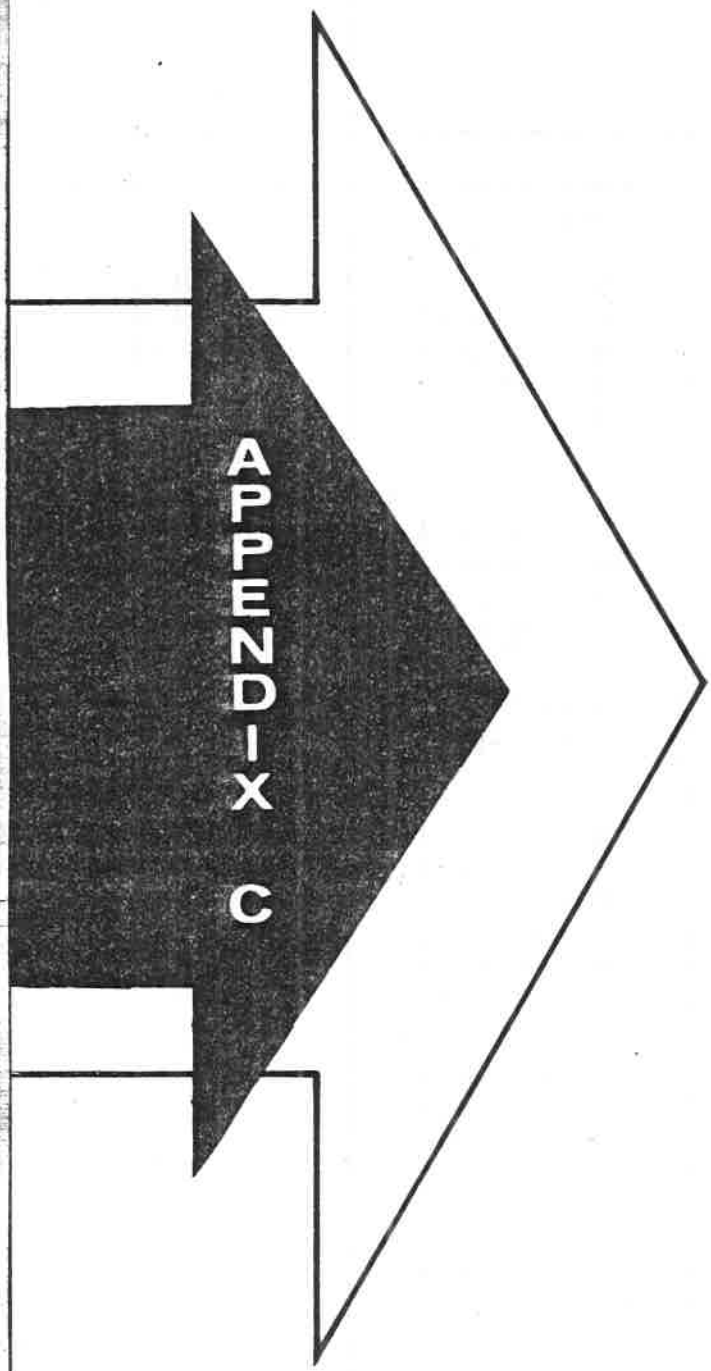
HELICOPTER POSITIONS

Holding Area—A site that may be occupied for short intervals while aerial scouts coordinate attack helicopter movement into attack positions and/or firing positions.

Attack Route—A corridor used by attack helicopters to move from the holding area to the attack position.

Attack Position—It is a maneuvering area which contains firing positions, laterally and in depth, for the attack helicopters.

Firing Position—A position occupied by an individual attack helicopter in order to engage targets.

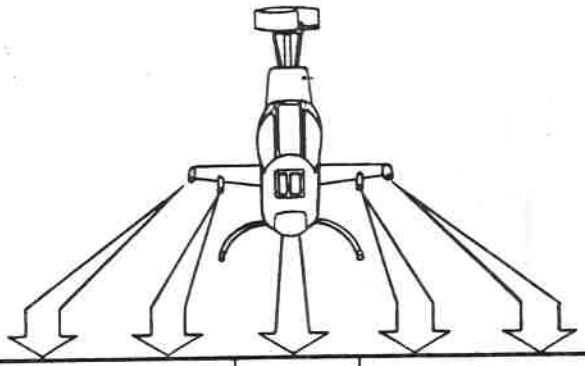


HELICOPTER ARMAMENT DATA

INTRODUCTION

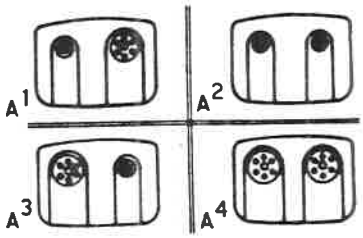
Various armament configurations are authorized for the AH-1G, AH-1Q, and UH-1B/C/M attack helicopters. This appendix identifies the armament configurations most commonly used by each helicopter. It also identifies performance data for each weapon subsystem.

AH-1Q AUTHORIZED ARMAMENT CONFIGURATION



WING STORES		TURRET	WING STORES	
		* A		
	B	* A	B	
B	B	* A	B	B
	C	* A	C	
C	C	* A	C	C
B	D	* A	D	B
C	D	* A	D	C
E		* A		E
F		* A		F
F	C	* A	C	F
F	D	* A	D	F

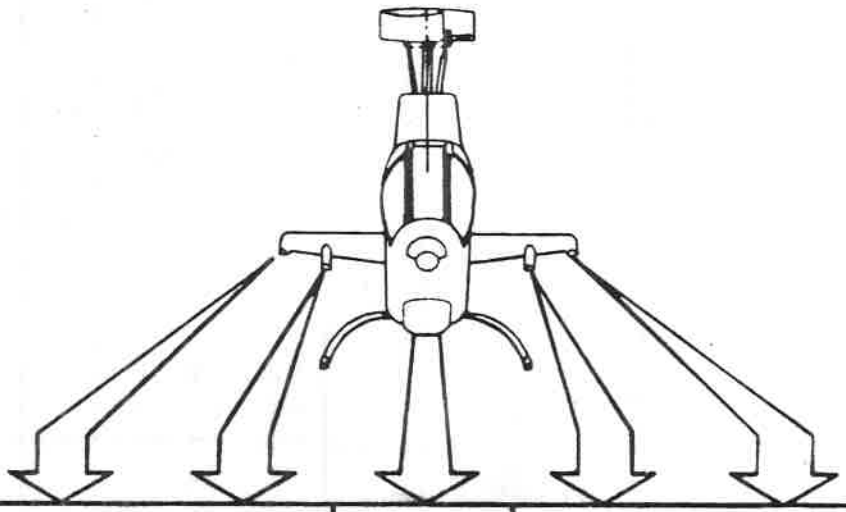
*M28A1E1 SUBSYSTEMS



*M28A1E1 turret subsystems are interchangeable and may be used in conjunction with all approved wing store configurations.

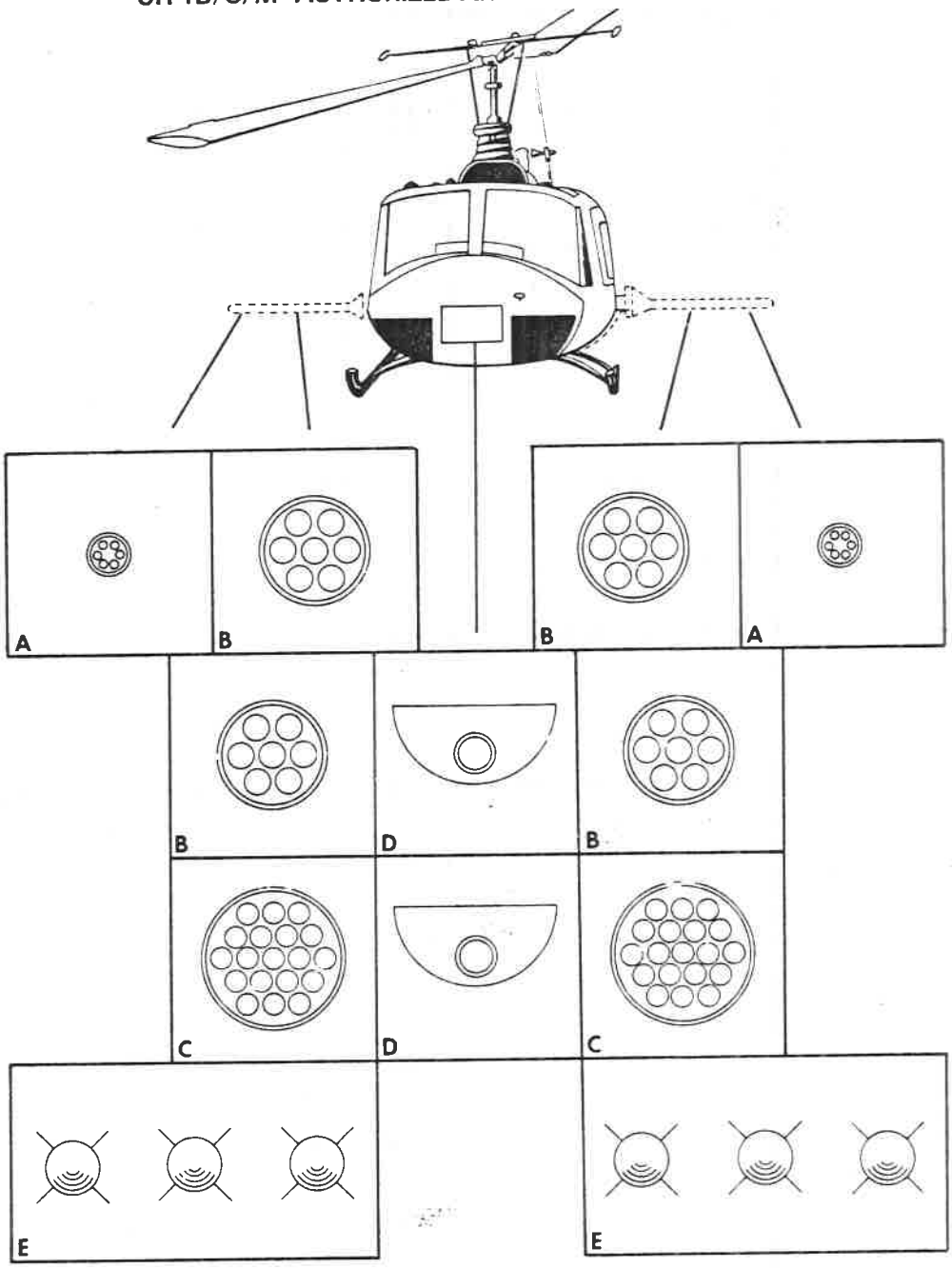
A^1	M28A1E1	Left, 7.62mm automatic gun; right, 40mm grenade launcher
A^2	M28A1E1	Two 40mm grenade launchers
A^3	M28A1E1	Right, 7.62mm automatic gun; left, 40mm grenade launcher
A^4	M28A1E1	Two 7.62mm automatic guns
B	M157	Seven-tube, 2.75" rocket launcher
C	M159 or M200	19-tube, 2.75" rocket launcher
D	M18	7.62mm gun pod
E	M118	Smoke grenade dispenser
F	TOW	Two or four TOW missiles

AH-1G AUTHORIZED ARMAMENT CONFIGURATIONS



WING STORES		TURRET	WING STORES	
			G	
B			G	B
C			G	C
B	D		G	B
C	D		G	C
	D		G	

UH-1B/C/M AUTHORIZED ARMAMENT CONFIGURATION



A M134: 7.62MM, HIGH RATE AUTOMATIC GUN
B M158A1: SEVEN-TUBE, 2.75-INCH ROCKET LAUNCHER
C M200A1: 19-TUBE, 2.75-INCH ROCKET LAUNCHER
D M5 SUBSYSTEM: 40MM GRENADE LAUNCHER
E M22 SUBSYSTEM: WIRE-GUIDED MISSILE

Table C-1. AH-1G/AH-1Q Armament Subsystem Performance Data*

Item	TOW	M28A1[b]		M18A1	M35	M158A1	M200A1
Ammunition type	BGM-71A	7.62mm	40mm	7.62mm	20mm	2.75-in.*	2.75-in.*
Ammunition capacity [rounds]	8	4,000	300	1,500	1,000	7	19
Weight [lb]	416	260	228	83	671	144	390
Range [meters]:							
Maximum	3,750*	3,200	2,000	3,200	3,750	9,300	9,300
Effective	3,750	1,100	1,600	1,100	3,000		
Minimum	500	100	300	100	300	300	300
Rate of fire:							
Shots per minute (guns)		2,000/4,000	400	2,000/4,000	750		
Pairs per second (rockets)						6	6
Flexible limits:							
Elevated		+20°	+20°				
Depressed		-50°	-50°				
Horizontal, right and left		110°	110°				

*Range of extended range TOW missile system.

Table C-2. UH-1B/C/M Armament Subsystem Performance Data

Item	M5	M21		M22
Ammunition type	40mm	7.62mm	2.75-in.	AGM22B
Ammunition capacity [rounds]	300	6,400	14	6
Weight [lb]	228	416	288	402
Range [meters]:				
Maximum	1,750	3,200	9,300	3,500
Effective	1,200	1,000	2,500	3,500
Minimum	300	100	300	500
Rate of fire:				
Shots per minute (guns)	220	4,000/4,800		
Pairs per second (rockets)			6	
Flexible limits:				
Elevated	+15°	+10°		
Depressed	-35°	-85°		
Horizontal, outboard		70°		
Horizontal, inboard		12°		
Horizontal, right and left	60°			

APPENDIX D

AERIAL DOOR GUNNER TRAINING PROGRAM

TRAINING OBJECTIVES

To train and qualify selected enlisted personnel to provide suppressive light automatic weapons fire and general armed security for utility and cargo class helicopters conducting tactical operations.

To provide door gunner personnel with the knowledge necessary to assist in first echelon maintenance and inspection of assigned aircraft.

To familiarize qualified door gunner personnel with the unit's tactical mission.

TRAINING MODULE I: BASIC WEAPONS QUALIFICATION

Training objective: To provide initial M60 qualification for enlisted personnel assigned to door gunner positions.

Subject	Scope	References
1. Operation and functioning of the M60	Conference to provide the basic knowledge of how the components function and their interrelationship during operation	FM 23-67
2. Assembly, disassembly, and nomenclature of the M60D	Demonstration and practical exercise on the general and detailed assembly, disassembly, and nomenclature of the M60 machinegun	FM 23-67
3. Malfunctions, stoppages, immediate action, and maintenance	Conference to provide information concerning abnormal operation, corrective action, and maintenance	FM 23-67
4. M60 machinegun and familiarization firing	Practical exercise in familiarization firing in preparation for record fire	Range SOP, FM 23-67
5. M60 machinegun record fire	Practical exercise/record fire to provide qualification with the M60 machinegun	Range SOP, FM 23-67

TRAINING MODULE II: AERIAL QUALIFICATION

Training objective: To qualify selected personnel in the techniques, skills, and duties of aerial door gunners.

Subject	Scope	References
1. Duties of the door gunner	Conference on the duties of door gunners	Unit SOP; TC 1-4; FM's 57-35, 90-4
2. Aircraft familiarization and orientation	Conference and practical exercise to familiarize the student with unit aircraft to include capabilities and configuration	Appropriate aircraft operator's manual (-10)
3. Techniques of fire and employment	Conference on the principles and techniques of aerial machinegun fire	TC 1-4
4. Armament subsystem introduction	Conference to provide a working knowledge of the appropriate armament subsystem to include nomenclature, safety procedures, and operator maintenance	TM 9-1005-262-14
5. High threat environment	Conference to familiarize door gunners with the high threat environment to include threat aircraft and equipment and their employment	FM's 90-1, 44-30; TC 1-88
6. Visual search and target detection	Conference on the techniques of visual search to include limitations and procedures of target detection	FM 1-80; TM 1-380-series
7. Crewmember emergency procedures	Conferences and demonstration of duties and actions taken by the door gunner during inflight and forced landing emergencies	Operator's manual (-10); Unit SOP

Aerial Qualification (Continued)

Subject	Scope	References
8. Night gunnery	Conference on techniques and procedures of night firing	Unit SOP; Range SOP; TC 1-28
9. Aerial gunnery qualification	Practical exercise in aerial gunnery firing with appropriate armament subsystem	Range SOP; TC 1-4; FM 23-67; TM 9-1005-262-14
10. Aeromedical training	Conference on the principles of first aid to include capabilities and limitations of the human body in the aviation environment	FM 21-11; TC 1-20
11. Survival, escape, and evasion	Conference on evading the enemy and basic survival following a forced landing	FM 21-76
12. M24 gas mask	Conference and practical exercise on description, capabilities, limitations, and procedures for wearing the M24 gas mask	TM 3-4240-21-14

TRAINING MODULE III: ALLIED TRAINING

Training objective: To provide aerial door gunners that training required to qualify them to perform the additional duty of assistant crew chief and to assist in navigation.

Subject	Scope	References
1. Airframe and airframe components	Conference on major sections of the airframe structure and the location of the major compartments and the contents of each to include a walk-around inspection	All reference material contained in aircraft TM series
2. Flight controls	Conference on flight control and hydraulic systems with emphasis on inspection and servicing	
3. Powerplant and related systems	Conference on the engine(s), fuel, and engine lubrication systems with emphasis on inspection and servicing	
4. Loads	Conference and practical exercise on internal and external loading to include radio communications/procedures, crew coordination, and arm and hand signals.	
5. Powertrain	Conference on the powertrain system(s) location, inspection, and servicing	
6. Rotor systems	Conference on the rotor system(s) and components location, inspection, and servicing	
7. Inspections	Practical exercise on daily inspections with emphasis on preflight, postflight, and servicing	
8. Ground handling and servicing	Conference on ground handling, refueling procedures, and care and handling of POL	

APPENDIX E

AERIAL GUNNERY SAFETY

GENERAL

Aerial gunnery training uses live ammunition to provide a realistic training situation. However, this live firing does not preclude the application of safety procedures in the training environment. Each unit will develop range firing and safety standing operating procedures applicable to its special situation. Range safety includes flight safety, firing safety, and ground safety. (For helicopter aerial gunnery safety regulations, see AR 385-62 and AR 385-63.)

FIRING SAFETY

Range safety requirements for firing aerial weapons are contained in AR 385-62 and AR 385-63. (For safety requirements for each subsystem, see the applicable 9-series and 55-series -10 TM's (appendix A).) In addition to the inspection of individual weapons, firing safety includes insuring that—

➡Clearance is received from the controller.

➡The weapon is on or past the start fire line (SFL).

➡Weapons are pointed downrange and within the range fan limits.

➡If on the ground, no one is in front of the weapons or in the back blast area.

➡No other aircraft are within the surface danger area.

➡The weapons are not fired at less than the minimum safe slant range.

➡Prior to leaving the range, a visual and physical safety inspection is made of each weapon.

GROUND SAFETY

Ground support personnel must constantly be made aware of the dangers involved in live fire training. Support personnel will be trained in the care and handling of ammunition, loading and unloading procedures for each weapons subsystem, and procedures for working near operating helicopters. Reloading areas should be separated from refueling areas. In addition, support personnel should be drilled in their duties for emergency situations.

FIRING SAFETY RULES

➡Whenever possible armament subsystems will be pointed downrange or away from all populated areas during all range operations.

➡Armament subsystems are considered safe for range traffic pattern operations under "switches off" conditions. (Refer to the appropriate technical manual for correct safing procedures for the weapons system.)

➡Armament subsystems may be placed in the "arm" position only if all of the following conditions are satisfied. First, the helicopter must be on or past the start-firing line and pointed downrange in the firing lane. Secondly, no other aircraft are downrange in the range danger zone. (Helicopters maintaining lateral positions to each other may be cleared by the control tower to conduct formation firing and team training.) Finally, clearance must be received from control tower or an airborne controller to arm the weapons.

➡The operation and position of the arming switch is the responsibility of the instructor pilot or pilot in command.

➡When conducting NOE hover fire, the armament system will not be armed until arriving at the firing position.

➡Whenever possible, helicopters will be flown at an altitude and over terrain where a forced landing could be safely completed.

PERSONNEL RESPONSIBILITIES AND DUTIES

A live fire range may not be operated without the range control officer or OIC being present. Personnel involved in attack helicopter range operation must maintain continuous surveillance over all aspects of range operation and report unsafe conditions to the officer in charge or to the range control officer. The proper loading, boresighting, stoppage clearance, and range firing procedures and safety precautions prescribed in this appendix and contained in applicable references must be followed.

OFFICER IN CHARGE (OIC)

Responsibilities

- Senior officer of participating unit using range.
- Responsible for overall supervision of range personnel and enforcement of range safety.
- The OIC may be airborne conducting training. When not physically on the ground, he must maintain radio communication with the range control officer.

Duties Checklist

Prior to Firing—

1. Obtain present and forecasted weather.
2. Assign helicopters to aircrews.
3. File flightplan.
4. Verify that required personnel and equipment are present.
5. Verify ammunition loading by type and amount with senior armorer.
6. Brief range control officer.
7. Prescribe altitude and routes to the range.
8. Monitor helicopter maintenance difficulties and coordinate any required maintenance.

During Firing—

9. Supervise flight operations and safety procedures.
10. Periodically observe and spot check ground operation.

After Firing—

11. Verify the range is closed and complete reports as required.
12. Debrief as necessary.
13. Supervise completion of reports and flight folders as required.

RANGE CONTROL OFFICER (RCO)

Responsibilities

- Control firing on the range.
- Insure safe operation of the range.
- Know range SOP and aircraft and armament emergency (preaccident) plan.
- When firing is conducted at locations where the RCO cannot control firing from the ground, the airborne OIC or his designated representative has primary responsibility for range safety at that location.

Duties Checklist

Prior to Firing—

1. Obtain a range briefing from the post range officer as required by current local range regulations.

2. Inspect firing line area, parking areas, ammunition loading areas, and area of range visible from control tower for safety hazards and proper positioning of vehicles, helicopters, and equipment.

3. Insure range flag is raised.

4. Contact range headquarters for clearance to fire; record name of person giving clearance and time.

5. Before firing, insure that medical aidman, ambulance, and ambulance driver are present; range flag is up; and range sweep by helicopter is complete.

During Firing—

6. Maintain positive radio control of all helicopters operating on the range.

7. From the control tower, observe all visible range activities for efficiency and safety.

8. As helicopter control situation (proficiency of radio operator/controller) permits, report to official visitors and inspecting officers.

9. In areas of high temperatures and/or high altitudes, advise aircrews of the density altitude.

10. Release POL vehicle when all scheduled refueling is completed.

11. Maintain a record by name of personnel aboard each helicopter.

12. Maintain a record of the number of helicopter armament stoppages (by helicopter tail number and total time lost).

After Firing—

13. Close range with range headquarters as required by range regulations and record time and name of person receiving report.

14. Inspect range area to insure that the range flag has been lowered, all buildings and tower are secured, and operating areas (firing line, tower, and parking areas, excluding downrange) are policed of cartridge cases and trash.

15. Release armament detail, crash-rescue team ambulance, and maintenance personnel when firing is completed. Depart only after last helicopter is airborne.

AVIATOR SAFETY OFFICER (ASO)

Responsibilities

➡Insure the safe operation of the range.

➡Be thoroughly familiar with the range SOP and aircraft and armament emergency plan.

➡Be knowledgeable in the proper storing, handling, and loading of ammunition and fuel.

➡Know the duties of all range personnel.

Duties Checklist

1. Continually observe all aspects of range operation and report unsafe conditions to the OIC or RCO.

2. Conduct the safety portion of the range briefing as specified in the local lesson plan.

3. Brief senior armorer. Determine deficiencies of personnel and/or equipment. Prescribe vehicle parking area and organization and operation of crew to service attack helicopters. Review the following safety precautions as required:

➡Approach attack helicopter from side only, staying clear of rotors and subsystems' flexible limits of movement.

➡Inspect each weapons subsystem for safety prior to loading for firing.

➡No smoking allowed within 50 feet of helicopters or ammunition.

➡Use protective devices; i.e., earplugs, dust goggles.

➡Use containers for collection of ammunition and brass.

4. Brief NCOIC of ammunition detail. Determine ammunition count and any equipment deficiencies. Check the organization and operation of the ammunition detail and review the following safety precautions as required:

➡Safe handling of ammunition.

➡Cleanliness of ammunition.

➡No smoking allowed within 50 feet of ammunition or helicopter.

➡Use of protective devices available; i.e., earplugs, dust goggles.

➡Control loose rounds.

5. Brief refueling personnel on helicopter refueling and vehicle parking areas and range safety.

6. Observe safety procedures during the conduct of fire.

7. Observe safety procedures during ground operation.

8. Inspect the firing line area, parking area, ammunition loading areas, and area of range visible from RCO position for safety hazards and proper positioning of vehicles, helicopters, and equipment.

9. Inspect crash rescue equipment and report any deficiencies in equipment or training of personnel.

10. Insure that a preaccident plan is in effect and all concerned personnel are knowledgeable of the plan.

11. Observe the safety procedures of the armorer crew and determine any deficiencies of equipment and/or personnel.

12. Insure that all personnel working near or on operating helicopters use hearing protection devices and have their sleeves rolled down and shirts tucked in.

13. Insure no smoking in hazard areas.

14. Observe safety procedures of POL personnel and check for any deficiencies in equipment and/or personnel.

15. Insure that all POL personnel use proper procedures in refueling aircraft and vehicles.

16. Insure that no FOD is present in parking area or flight line.

17. Insure that RCO/controller has a copy of the preaccident plan.

18. Insure that EOD personnel are available and knowledgeable.

19. Insure that a diagram showing location of all range facilities, range fan information and flight routes, minimum altitudes, other impact areas, low level hazards to flight, and possible caution area be displayed in the central tower.

20. Conduct gunner/pilot safety and range briefing as specified in the local lesson plan.

21. Inspect firing line area, parking areas, ammunition loading areas, and area of range visible from control tower for safety hazards and proper positioning of vehicles, helicopters, and equipment.

22. Brief crash-rescue team and inspect firefighting vehicle and equipment for deficiencies.

A minimum of two qualified crewmen is required. Brief the crew leader on—

➡Desired standby location to insure immediate availability to control tower or vehicles.

➡Helicopter range, orbit operating areas, and specific range activities for firing to be conducted each day.

➡Knowledge of access routes to helicopter operating areas.

➡Notification and dispatch of emergency crew (will only be by RCO or radio operator/controller).

➡Methods of emergency clearing of armament subsystem in crash-rescue operations.

➡General crash/emergency procedures as prescribed in aircraft and armament emergency (preaccident) plan.

23. Brief the ambulance driver on route to take to the hospital and check qualification of the medical aidman. Also, inspect ambulance vehicle and first aid equipment. The following equipment must be present:

➡Two litters and blankets

➡One first aid kit and splint set

➡Salt tablets

➡Two canteens of water

INSTRUCTOR PILOT

Responsibilities

- Be thoroughly familiar with the unit range SOP aircraft and armament emergency (preaccident) plan, and local accident report form.
- Be qualified and current in weapons subsystems.
- Insure operation of assigned helicopter and weapons subsystem in accordance with prescribed procedures and applicable safety precautions.
- Be on board helicopter when the aviator is not qualified or current in the weapons system.
- Be familiar with the azimuth of range and sector azimuth limits.
- Direct arming and de-arming of weapons subsystem.
- Insure conduct of training as prescribed in local lesson plan.

Duties Checklist

1. Check for proper procedures and safety in loading, boresighting, test firing, and stoppage clearance by all personnel in the vicinity of the helicopter.
2. Continually observe all aspects of range operation and report unsafe conditions to the OIC, RCO, or ASO.
3. Insure safe operation of the helicopter and weapons subsystems.
4. Insure that firing is conducted only when the helicopter is on course and all weapons are aimed at the target.
5. Perform all required radio reports.
6. Insure that all live ammunition is cleared from the helicopter at the conclusion of the firing period.
7. Complete reports and evaluations as required.
8. The pilot in command is authorized to conduct the above duties when the other aircrewmember is qualified and current in the helicopter.
9. Compute gross weight allowable based on density altitude and firing mode.

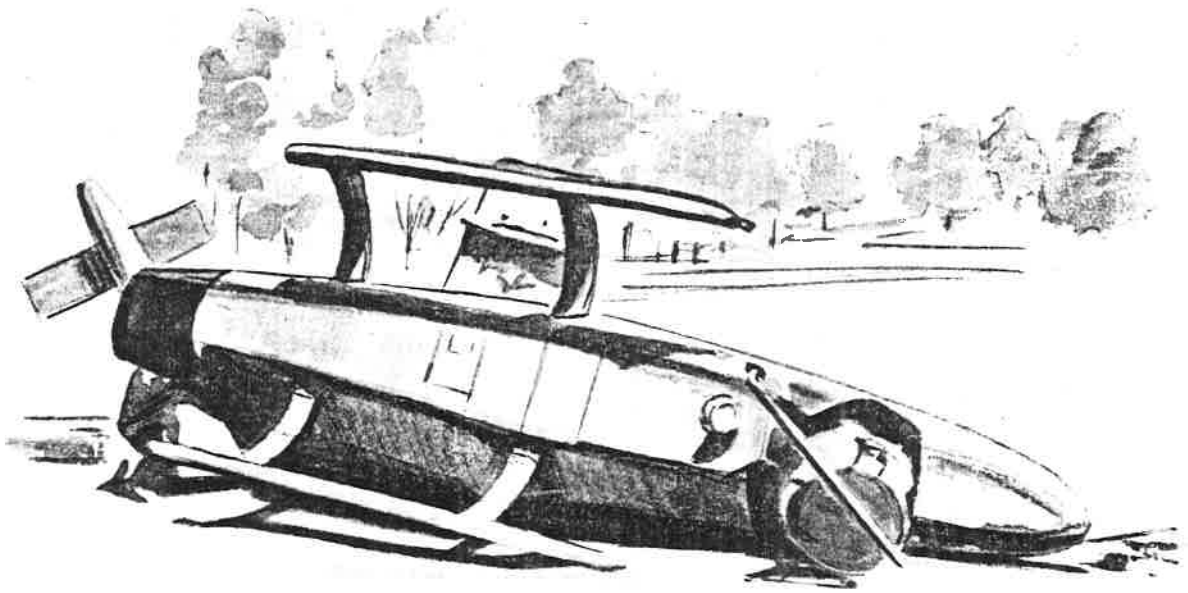
RADIO OPERATOR/CONTROLLER

Responsibilities

- Insure that radios are working properly.
- Be thoroughly familiar with range SOP and aircraft and armament emergency (preaccident) plan.
- Assist RCO as directed.

Duties Checklist

1. Review range SOP.
2. Put up range flag.
3. Turn on range tower radios, and make sure they are working properly.
4. Open range upon order of RCO.
5. Assist RCO in traffic control as per range SOP.
6. Close range upon order of RCO.
7. Turn off and secure all radios.
8. Take down range flag.



SENIOR ARMORER

Responsibilities

➡ Insure the control and proper use of enlisted personnel on the ground.

➡ Insure that proper equipment and required personnel are at the range to conduct firing and give necessary ground support.

➡ Insure that the proper amount and type of ammunition is on hand for range firing.

Duties Checklist

Prior to Firing—

1. Check personnel and equipment.

2. Obtain helicopter tail numbers and verify that ammunition loading is correct.

3. Assign duties to crew (armorers to helicopter and driver to vehicle, etc.).

4. Brief crew on the location of helicopter and vehicle parking areas, the type of firing table, and ammunition load. Review the following safety precautions as required:

➡ Approach and depart vicinity of helicopter from side only after visual recognition from instructor pilot in the helicopter.

➡ Last man to leave vicinity of helicopter will give "all clear" signal to instructor pilot.

➡ Remain to rear of loaded subsystem at all times.

➡ Secure subsystem before anyone enters or leaves the helicopter or as directed by instructor pilot.

➡ Remain clear of subsystem areas during boresighting, etc.

➡ Check subsystem only when arming switch is in "safe" position as directed in appropriate TM and unit SOP.

➡ Check proper installation of safety bridles.

➡ No smoking within 50 feet of ammunition or helicopter.

➡ Use available protective devices, i.e., ear protectors.

➡ Secure loose equipment in helicopter.

5. In case of emergency, stay at duty position until directed otherwise by officer or NCOIC.

6. Visually inspect range area on and behind firing line for safety.

During Firing—

7. Supervise all armament crew activities for operation and safety.

After Firing—

8. Police firing line separating live rounds and expended brass in specified container for turn-in to ammunition area.

9. Police range areas behind firing line (parking areas, in vicinity of tower, etc.).

10. Check security of buildings and equipment on the range, classroom/briefing area.

AMMUNITION NCOIC

Responsibilities

- Insure safe handling and loading of ammunition.
- Supervise detail at all times.
- Police area during and after firing.
- Control loose rounds.

Duties Checklist

1. Brief detail as follows:
   - Safe handling of ammunition
   - Loading procedures
   - Safety measures for ammunition and helicopter
   - Location of vehicle and helicopter parking areas
2. Supervise detail at all times.
3. Police area during and after firing.

AIRCRAFT EMERGENCY (PREACCIDENT) PLAN

The aircraft emergency (preaccident) plan prescribes the procedures to be followed in the event of an aircraft emergency (accident, incident, or inadvertent firing) during conduct of range firing.

The aircraft emergency plan should provide the immediate notification to the RCO, OIC, and ASO of an accident. The preaccident plan will be initiated upon receipt of this notification. The notification should include:

➡Location of accident

➡Time accident occurred

➡Type aircraft involved

➡Injuries to personnel, if any

➡Other pertinent facts available

The RCO will take the following actions upon the notification of an accident.

➡Dispatch (request if not on hand) ambulance and crash-rescue team to the site simultaneously with the radio or telephone report.

➡Designate one helicopter to proceed to crash site to assist the medical evacuation crash-rescue teams and to establish radio communications at the crash site.

➡Direct remaining helicopters to firing line or loading area to await further instructions.

➡Notify post range officer by telephone. Request that other ranges cease fire until further notice, depending on the location of the crash.

➡As soon thereafter as possible, the accident must be reported to the immediate supervisor, commander, or operations officer. Individuals involved in an accident will complete a report (on the local form provided) at the scene of the accident as soon as practical and turn it in to the unit safety officer.

ARMAMENT MALFUNCTION PLAN

Malfunctions include—

➡*2.75-inch FFAR hangfires.* If a 2.75-inch FFAR hangfire occurs in a UH-1B/C/M or AH-1G helicopter, care must be taken not to overcontrol the pedals and thus cause an overstressing of the tail rotor and loss of control.

➡*Runaway guns.* The pilot will make every attempt to keep the runaway gun pointed downrange so as to keep the impact of the rounds in the impact area.

➡*Duds.* The instructor will report the malfunction and execute the proper emergency as outlined in this operator's manual.

The RCO will dispatch explosive ordnance disposal personnel when present on the range or request their assistance through appropriate channels when an immediate requirement to eliminate explosive hazards exists.

The RCO will also notify the range safety officer and the post ammunition officer of the type, location, and nature of the ammunition malfunction. The ammunition officer may obtain the assistance of explosive ordnance disposal personnel, if they have not been contacted, and will investigate malfunctions.

SAFETY CONTROL PLAN

A diagram will be made outlining each range. This diagram will show the location of range facilities, any appropriate range fan information, and flight routes to and from the firing lane. Examples of specific safety instructions include—

➡ Minimum altitudes to be flown over adjacent areas.

➡ Other range impact areas to be avoided.

➡ Hazards to flight during low altitude runs on targets, e.g., high trees at the end of the firing lane.

RANGE FACILITIES

Range flag(s), road guards, and range markers are as prescribed by local range regulations. Range facilities include the following:

➡ *Control tower.* A control tower should be located on each firing range. Each tower is equipped with radios, telephones, and an emergency warning device. If a control tower is not available, a 1/4-ton vehicle with radio positioned to enable the controller to observe firing lanes and targets or an airborne controller may be used.

➡ *Hover firing points.* Hover firing points located within the firing lane should be marked, e.g., colored tires or PSP.

➡ *Cease-fire line.* A cease-fire line should be visible to the aircrew when firing from terrain flight altitudes.

➡ *Start-fire line.* The start-fire line on each range may consist of an asphalt or concrete pad, with parking spots marked for each helicopter. Approaches to and from the start-fire line will be kept clear of all vehicles, obstructions, and loose objects likely to interfere with helicopter operations.

➡ *Helicopter parking areas.* When available, helicopter parking areas are located adjacent to the start-fire line and are used by all helicopters not actively engaged in training. Parking areas may be located on or near the start-fire line previously discussed. Helicopter landing areas should be protected from dust to prevent visibility hazards and damage to helicopter components.

➡ *Vehicle parking areas.* When space is available, separate vehicle parking areas are located clear of all aircraft operations. If separate parking areas are not available, parking areas will be located near the control tower on the opposite side from the firing line. Whenever possible, military vehicles will be unloaded and parked in designated areas away from aircraft operations. Civilian vehicles will be parked in designated areas completely clear of all aircraft and military vehicle operations.

➡ *Ammunition areas.* When applicable, ammunition areas are located in an area separate from other activities and adjacent to the helicopter parking area. Whenever possible, ammunition preparation and loading activities should be shielded from blowing dust and dirt.

➡ *Radio communications.* Two-way radio communications will be established and maintained with all helicopters operating on the range.

➡ *Telephone communications.* Telephone communications with range headquarters will be established and maintained at all times while the range is in operation. In an emergency, radio communication to another range tower that has telephone communication is acceptable until emergency repairs are completed.

CHECKLIST FOR LOADING AND UNLOADING AMMUNITION

1. The entire traffic pattern from the ammunition loading site to firing lane, return to firing lane, and return to loading site is established by a plot or map. The course is selected so that any accidental firing at any point on the course will not result in hazard to life or property.

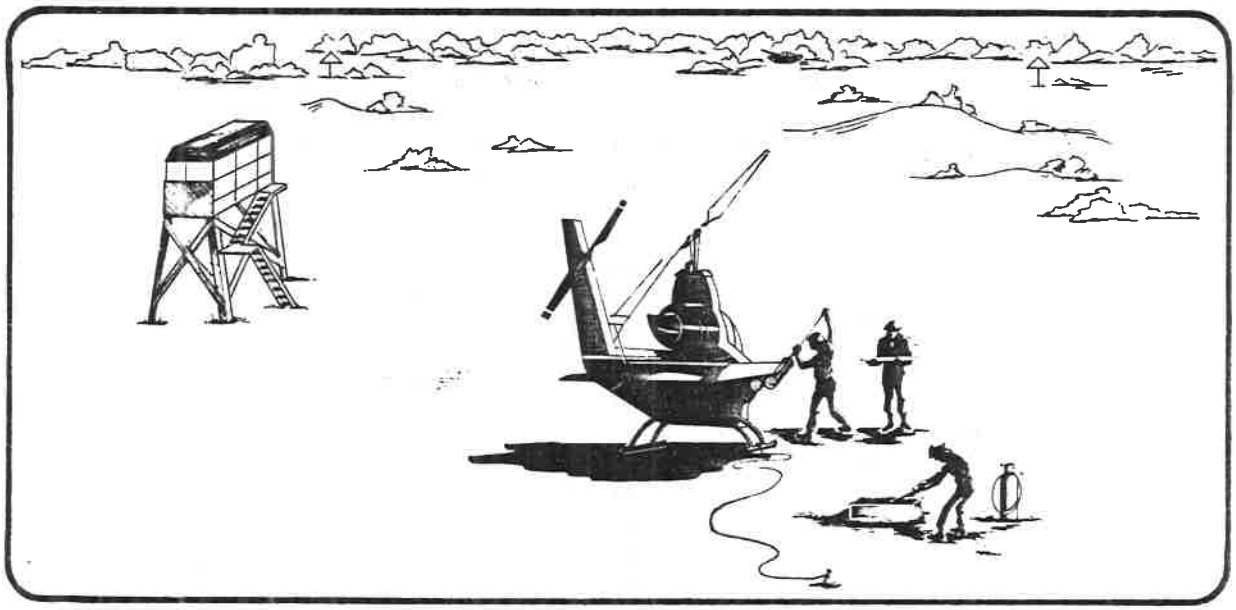
2. An emergency holding course is designated. In the event of misfire, malfunction, possible cookoff, or emergency conditions, the pilot will automatically proceed to this course until steps can be taken to provide for the emergency or the pilot is authorized by the officer in charge of the installation to land under emergency conditions.

3. All weapons are safed before any attempt to inspect/remove ammunition. See caution in pertinent TM's for safing weapon.

4. Prior to loading and unloading rockets, the helicopter is grounded, the helicopter battery and external power source disconnected, and qualified personnel have checked for stray voltage. All radio transmitters are turned off.

5. No mobile or portable radio communications equipment is transmitting within 16 meters of a loaded helicopter.

6. Switches are not placed in the ARMED position and the helicopter is at or past the start-fire line. Switches are placed in the SAFE position before reaching the cease-fire line. When maneuvering to the hover firing points, switches are not placed in the ARMED position until arriving at the firing point and placed in the SAFE position prior to departing.



RANGE FIRING CHECKLIST

Prior to Firing—

1. Range guards must be posted.
2. Crash rescue team and ambulance must be in position.
3. Medical evacuation helicopter must be available.
4. Control element must be in operation.
5. Range flag must be flying.
6. Range must be checked to insure that no personnel are in the surface danger area.
7. Permission must be received from the range officer to commence firing.
8. Proper arming and disarming equipment must be available, i.e., ground safety wires.
9. Aircrews must be briefed on runaway gun/hungrocket emergency procedure.

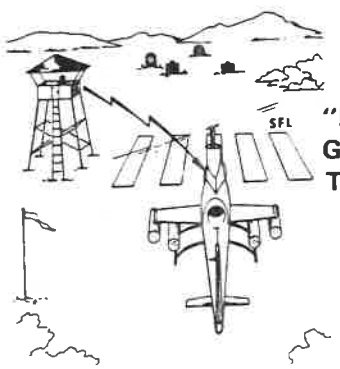
During Firing—

All safety restrictions must be met during firing; otherwise, the OIC or the RCO is required to stop training until they are corrected. To properly control traffic, the following radio communications are mandatory:

1. Communications must be maintained between all aircraft or the tower or an airborne controller.
2. Permission must be received from the controller for all takeoffs, and landings.
3. Permission must be received from the controller before placing any switch in the "hot" (ARMED) position.
4. Controller must be notified when systems are "cold" (SAFE). The heading of the helicopter must remain pointed downrange until all weapons systems are safe.
5. Controller must be notified when "clear" of the surface danger area.

After Firing—

Upon completion of training, all aircraft will be cleared and unarmed before leaving the range. The range officer should be notified of the conclusion of training, the amount and type of ammunition expended, and the location of any known duds.



AIR SAFETY CHECKLIST

Weather

1. Minimum visibility for range firing is 1 statute mile.

2. Minimum ceiling for range firing is clear of clouds.

3. Wind limitations depend on the local flying regulations, helicopter flight limitations, and the judgment of the range control officer.

Helicopters

1. Helicopters must have at least one radio for two-way communication with the control tower.

2. Any unsecured equipment will be tied down before takeoff.

3. Passengers will not be carried in helicopters operating on the range unless individually approved by the range control officer.

4. Armament subsystem must be "secured" en route from the arming area to the firing range.

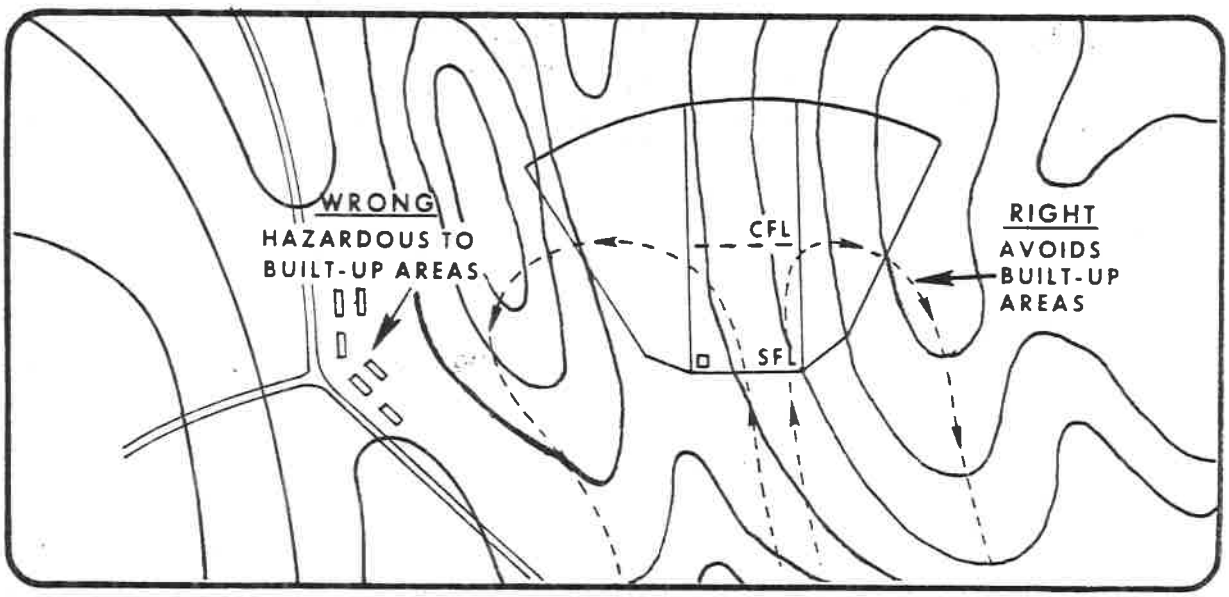
Routes

1. Terrain flight will be restricted to previously reconnoitered routes. All hazards to low-level flight (e.g., wire hazards, antenna) will be appropriately marked on an up-to-date map overlay. Overlays will show flight routes to and from ranges, specified flight altitudes, and obstacles to flight.

2. Routes will be selected to avoid built-up areas.

3. Minimum en route altitude away from populated areas is dictated by local regulation.

4. Routes should be selected which permit the weapons to be aimed away from built-up areas.



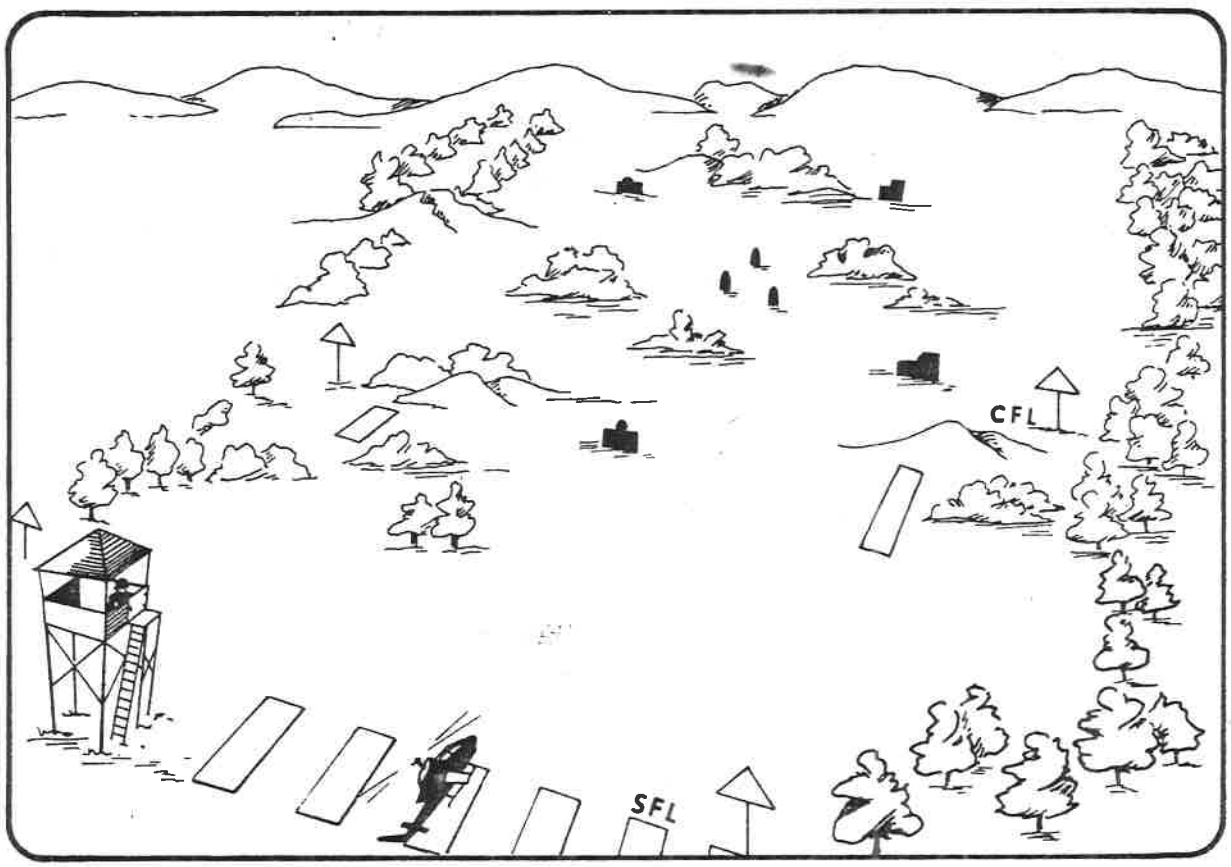
RANGE LAYOUT

When practical, the firing lane should be laid out on relatively open terrain to facilitate emergency landings. In addition, it is desirable for the CFL markers to be visible from the tower. To facilitate harmonization of weapons systems, the first 500 meters of the firing lane should be clear and on relatively flat terrain. When possible, terrain other than the firing lane should be left in the natural state to add realism to the training.

The SFL and CFL must be clearly marked and visible from the air. For control purposes, it is also desirable that they be visible from the tower. Landing pads on the firing line should be clearly marked for both day and night landings. Hover firing points should be easily recognizable during day and night.

The nature and arrangement of targets should be varied to provide the widest latitude in training. To facilitate harmonizing, one target should be placed at the harmonization distance for each weapon system.

When practical, the tower should be a permanent structure incorporating electrical power for heading, lighting, and radios, and direct land-line communications to range headquarters and the crash/rescue telephone net. For safety, the tower should be erected on the same side of the firing lane as the traffic pattern.



GROUND SAFETY RULES

➡Personnel will not pass in front of a loaded armament subsystem after the helicopter has landed.

➡When approaching the helicopter, approach from the 90° side position and only after receiving visual recognition from the aircrew.

➡All personnel will exercise extreme caution while walking under the main rotor arc or in the vicinity of the tail rotor.

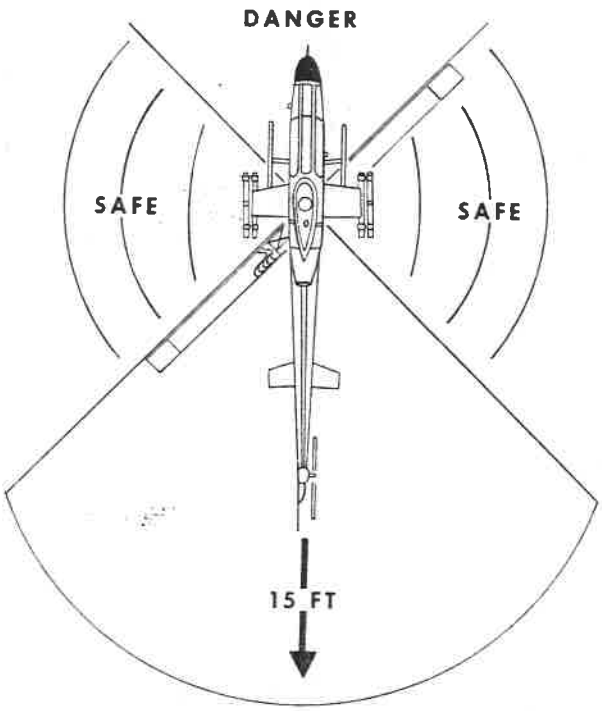
➡Helicopter will not be moved until an armorer moves out of the main rotor arc at the 90° side position and signals "all clear."

➡Prior to departure from the arming/de-arming area for home station, support personnel will remove all ammunition from the helicopter.

➡The helicopter must be grounded prior to any work being performed, or aircrew exiting or entering the helicopter.

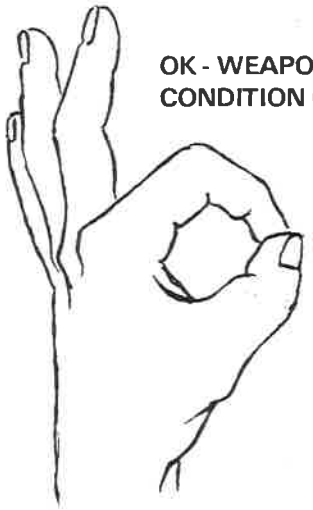
➡All personnel working on or near the helicopter will have their sleeves rolled down and use proper hearing protection devices.

➡When operations are being conducted at night, ground personnel will always carry a flashlight or wear a head lantern. When working in the vicinity of the helicopter, the light will be on.



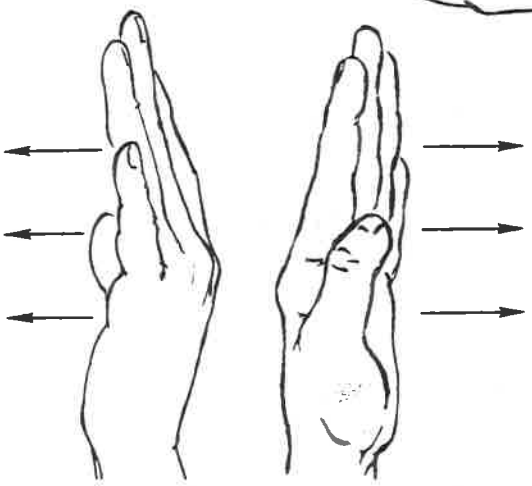
GROUND HAND SIGNALS

Hand signals are necessary to maintain communication between the pilot, gunner, and armorers servicing the armament subsystems mounted on the helicopter. The standard signals facilitate range operations, clearing of stoppages, and loading. During night operations, the cockpit light, a flashlight, or other hand-held lighting device is used by the aircrew to make the appropriate hand signals visible. Ground crew personnel will normally use a head lantern to make the hand signal visible. When available, a headset worn by a ground crewmember can be plugged into the helicopter intercommunication system.



OK - WEAPONS SIGHTED CORRECTLY, CONDITION CORRECTED.

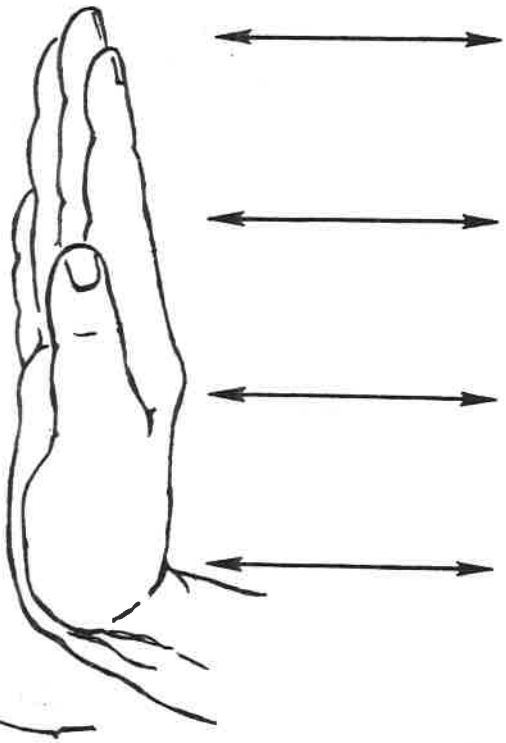
READY TO FIRE - CLEAR AND READY TO FIRE, INDICATED BY POINTING DOWN RANGE.

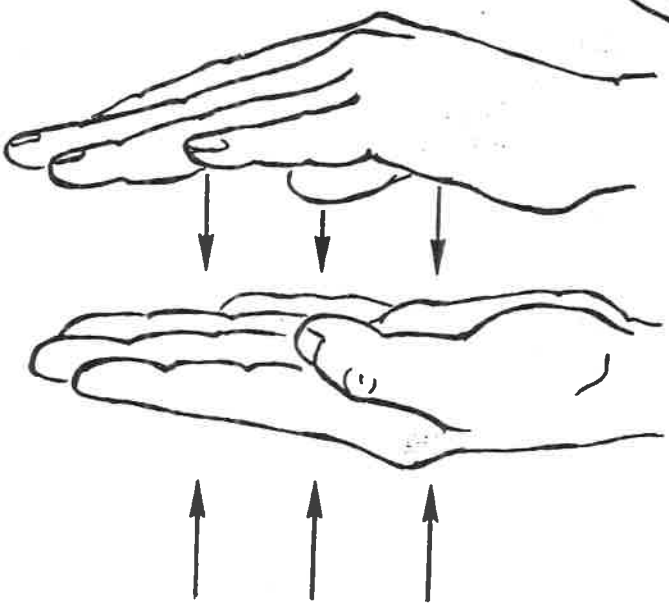


AZIMUTH ADJUSTMENT - HAND UP, PALM TOWARD DIRECTION ADJUSTMENT DESIRED.
MAGNITUDE OF MOVEMENT INDICATES RELATIVE AMOUNT OF ADJUSTMENT REQUIRED.

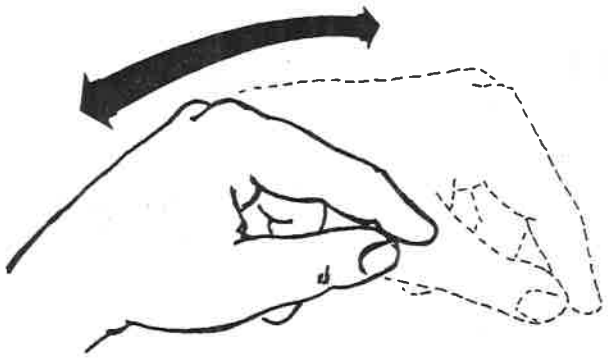
STOP! HOLD POSITION.

CLEAR AIRCRAFT- MOVE CLEAR OF AIRCRAFT BY A DISTANCE OF 50 FT.



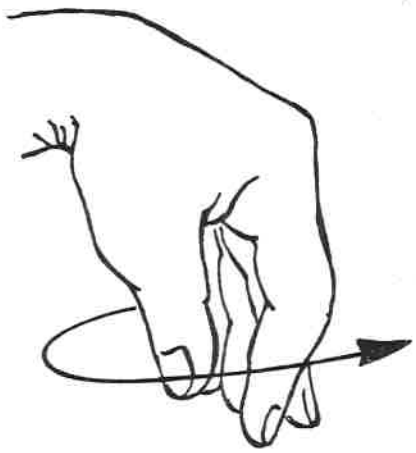


ELEVATION ADJUSTMENT- HAND OUT, PALM UP OR DOWN TO INDICATE ADJUSTMENT DESIRED.



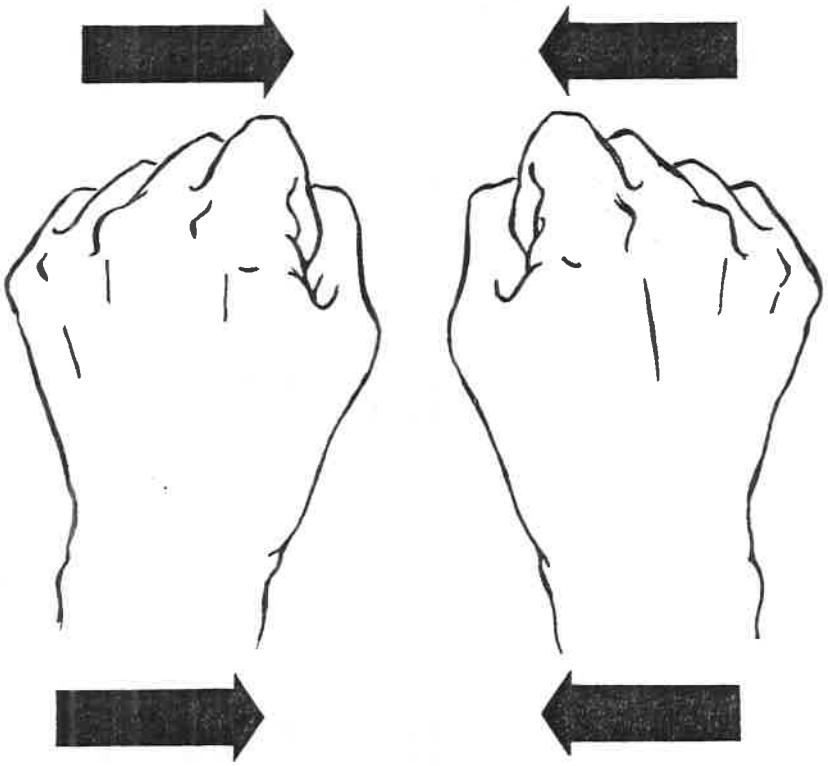
SAFE-ARM. SIMULATED MOVEMENT OF SWITCH TO REAR - PLACE SWITCH SAFE. SIMULATED MOVEMENT OF SWITCH FORWARD INDICATES PLACE SWITCH ARMED.

STOPPAGE OF BOTHS GUNS -
POINT TO SIDE ON WHICH STOPPAGE OCCURS.



CONNECT CANNON PLUG ON ROCKET LAUNCHER -
POINT TO SIDE TO BE CONNECTED.

MOVE HANDS TOGETHER. ARM SYSTEM (LOAD AMMUNITION).



MOVE HANDS APART. DISARM SYSTEM (UNLOAD AMMUNITION).

DEPRESS ACTION SWITCH.

TC 1-4

HELICOPTER GUNNERY

As the user of this publication, we are vitally interested in making you a member of our writing team. You are encouraged to provide us with your opinion of this publication by filling out this questionnaire. Please be sure to include your name, AUTOVON number, and unit so that we can follow up on your suggestion or comments.

Unit Address

_____ AUTOVON _____

_____ Name _____

1. Did you have any difficulty understanding the material presented in this publication? ____ Yes ____ No
   If your answer is Yes, which part(s) was unclear?

_____

_____

2. In your opinion, are the techniques and procedures realistic and useful? If your answer is No, or you think some changes are required, please explain. ____ Yes ____ No

_____

_____

3. Are you or your unit using any techniques or procedures that are not contained in this publication which you think should be added? If your answer is Yes, what are they? ____ Yes ____ No

_____

_____

4. To your knowledge, are any of the techniques or procedures contained in this publication in conflict with local regulations, directives, or unit SOP? If your answer is Yes, what are they and how are they prohibited? ____ Yes ____ No

_____

_____

5. Does this book contain any techniques or procedures that you feel cannot be performed by average attack helicopter aircrew? If your answer is Yes, which ones and why? ____ Yes ____ No

_____

_____

6. If you could, what would you do to improve this book?

_____

_____

7. Do you feel that information from any other publication should be included in this circular? ____ Yes
If your answer is Yes, which one and why? ____ No

_____

_____

8. Do you feel that the information in this publication might better serve the needs of attack helicopter aircrews if contained in some other manual? If your answer is Yes, which one and why? ____ Yes ____ No

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